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Some Problems of Agricultural Climatology in Tropical Africa

A. H. BUNTING

THE PRINCIPAL TASKS OF AGRICULTURAL CLIMATOLOGY are the prediction or interpretation of agricultural experience and the assessment of agricultural potentialities in relation to meteorological data. In the first case we seek to forecast or explain the events of a crop season, or the differences between crop seasons, by reference to short-term information about weather; in the second we attempt to predict farming possibilities from existing long- and short-term information about climate and weather. This paper is confined almost exclusively to the second of these problems. Africa is largely undeveloped, and one of the commonest problems put to the agriculturist concerned with development is the selection of suitable areas for investigation and the choice of methods of attack. The climatological problems involved are considered from the ecological and physiological viewpoint of an agronomist, against a background of agricultural development research in East Africa and the Sudan. The argument is concerned primarily with the growth of the wild and cultivated plants on which all agricultural production depends, and no attention is given to animal production, though it too involves many interesting climatological problems.

CLIMATIC ELEMENTS

Temperature

Apart from chemical and physical inadequacies of the soil, the principal environmental elements limiting plant growth in practice are temperature and water supply. In regions outside the tropics the incidence of low temperature is an important consideration, and we are well accustomed to the idea that plant growth is restricted to that part of the year in which the mean screen temperatures exceed a threshold value of 40° or 42°F. In continental climates the duration of the frost-free period is a sufficiently close approximation to this, and has the merit of minimizing the objections of the plant physiologist to the concept of the threshold temperatures, particularly when they are average temperatures determined several feet above the surface of the crop or soil in a louvred box.

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Though a threshold value, perhaps approaching 60°F more closely than 40°F, certainly seems to exist for some tropical crop species (e.g. maize), some of the more drought tolerant ones (e.g. safflower) can grow and develop at lower temperatures, while others (e.g. sesame) seem to require even higher average screen temperatures, up to 70°F, before they will germinate or grow vigorously. To the tropical crop botanist, therefore, the idea of a single universal temperature threshold value for plant growth has little utility, particularly since within individual species, such as maize, selection has produced varieties adapted to germinate and grow in temperate regions at markedly lower temperatures than are usual for the crop in the tropics.

Rainfall

In typically tropical regions (excluding here the areas of high altitude such as the Kenya highlands, where apart from constant day length and a much smaller annual range of temperature, the conditions approach those of temperate regions) water supply is the most important environmental element; and though cold and frost or, on the other hand, excessive heat, may occur, they usually do so in periods of the year when plant growth is primarily restricted by drought. So we are, in tropical agricultural climatology, concerned mainly with precipitation, its total amount and distribution in time and space, and its utilization by wild vegetation and crops. Temperature is important principally as a determinant of evaporation rates.

Hence the main climatic features of tropical Africa are roughly defined, so far as plant growth is concerned, by the isohyets. These have a crudely elliptical form, centred on the wet regions of West Africa and the Belgian Congo, where rain falls in every month of the year and where the wild vegetation is evergreen forest or successional to forest. Away from these wet areas we encounter the so-called savannah belt, of more open and usually deciduous woody vegetation with grass and herbs between the trees and shrubs. To many botanists, the term savannah seems unduly comprehensive since it includes virtually all tropical African vegetation from the open scrub of the desert fringe to the margins of the tropical high forest, covering a great diversity of forms of scrub, bushland, parkland and open to closed woodland. Like the evergreen high forest itself, virtually all of this vegetation is disturbed or secondary; surprisingly little African vegetation is in any sense "primeval". In the savannah areas, as we leave the forest, the rainless season generally increases in length until the desert is reached. It is worth noting that except at high altitude there are no primary grasslands in tropical Africa, apart from the more or less seasonal swamps and marshes.

To the north of the wet ellipse the isohyets run uniformly east and west, except for a northeasterly trend as they follow the northern margin of the Ethiopian and east African highlands, and the rainfall falls

off regularly to the desert margin. To the east, we find the dry country of the Horn of Africa, eastern Kenya and central Tanganyika. In the south we reach the arid and desert country of Bechuanaland and South West Africa. There are two main sources of precipitation: the west African source, consisting of moist Atlantic air bringing rain on southerly and southwesterly winds to west Africa, the Congo, the Sudan (west of the Red Sea Hills) and parts of Angola, mainly in May to October; and the southeast African monsoonal source providing the rainfall of east and central Africa and the Angola plateau between November and April. The convergences and divergences of these systems, together with orographic effects, account adequately, though perhaps not accurately, for the main features of the rainfall pattern.

The interpretation of rainfall data

Although much used, the mean total of annual rainfall has very limited significance for the agricultural assessment of climate in tropical Africa. Rainfall varies in seasonal duration as well as amount; the higher the rainfall total the longer the effective wet season. The central Congo, with over 70 inches of rain a year, has a wet season of 10 months in which it rains nearly every day, and a "dry" season of 2 when there is rain almost every other day. In the central Sudan, a rainfall of 28 inches is received in about 4½ months. Both these regions average about 6 inches of rain per wet month: while the rain continues, the temperature and humidity conditions in the central Sudan are very like those of the central Congo. During the rest of the year the central Sudan is an arid desert.

Clearly then the statement of the mean rainfall total must be amplified by some indication of duration, particularly since the length of the dry season determines the nature not only of the appropriate farming system, but also of the wild vegetation and the likelihood of bush fires. These fires (whether started by man or otherwise) are a regular feature of all regions with more than about 3 months of dry weather, and in such regions they prevent the establishment of evergreen forest and thicket species. In this way the spread of evergreen forest is especially held back in both Uganda and the Belgian Congo, and probably also in Angola, where the isohyets are relatively widely spaced.

It is a commonplace that rainfall is markedly variable from year to year, particularly in the drier regions on the unstable frontiers of the rainfall systems. At Kongwa, the headquarters of the east African groundnut scheme, a mean rainfall around 20 inches was represented by annual values ranging from 7 to 28 inches. The variability of rainfall in the Sudan, calculated by Ireland[1] as the mean linear departure from the long-term average, ranges from 10 per cent on a rainfall of 60 inches to 50 per cent on a rainfall of 4 inches. Manning[2] at Namulonge in Uganda has introduced a valuable method of calculation of confidence

limits for seasonal variations in rainfall, based on the computation, month by month, of the range within which rainfall may be expected to lie in one year out of two and he has applied this to the determination of the optimum sowing times of cotton and other crops.

Rainfall is also markedly variable in distribution within the rainy season. Each rainy season has a character of its own. Thus during the 1954 season at Tozi, in the central Sudan, 56 per cent of the total rainfall of 29·5 inches (55 rainy days) fell in storms of more than 1·85 inches, with leading-edge rates of up to 3·31 in./hour, while in the following year only 39 per cent of the total of 28·4 in. (78 rainy days) fell in storms of more than 1 inch, with leading-edge rates of up to 2·07 in./hour. Thus 1954 was effectively a much wetter year than 1955, even though the totals were similar. In addition to this sort of variability we have the problem of drought periods—usually taken as rainless periods of 14 days or more, which on lighter soils may be more than long enough, at tropical evaporation rates, to exhaust the reserve of soil moisture within root range and damage crops severely. In some regions, like central Tanganyika, which may receive rain both from the west and from the east, this may be accentuated by divergence of the two main rainfall systems; in others it is associated with the seasonal shift of one or other system, leading in the most extreme case to the double rainfall maximum of parts of Kenya and Uganda, which may be felt well down into Northern Rhodesia in the form of a dangerous dry gap around the first half of February. It also reflects another aspect of variability—the discontinuity of rainfall in space, shown at Kongwa and in the Sudan by the use of grids of rain gauges, read daily, to plot storm tracks. With local instability rainfall, storms may be no more than a mile wide and four or five long, and even the nocturnal, large-scale cyclonic rainfall of the central Sudan has a highly non-uniform structure in which individual storms, though they run for many miles, are often less than five miles wide and are sometimes less than one.

Finally storms may vary very much in intensity, which may be as high as 5 inches an hour, while 1 to 2 inches an hour is not at all uncommon. Since on sloping land this affects run-off and so the amount of water that is lost to the crop on which it falls, knowledge of this aspect is important in assessing the usefulness of rainfall.

All this makes the conventionally quoted mean total of annual rainfall a distinctly imprecise tool for agricultural purposes.

The effectiveness of rainfall

For plants, the usefulness of an inch of rain depends mainly on the length of time for which it will satisfy the needs of transpiration by supplying that continuous stream of water that must be drawn through most plants, as a penalty of their dependence on gas exchange through the stomata, if they are not to be restricted in growth, permanently

damaged or even killed by drought. The essential similarity of transpiration and evaporation has long been recognized by geographers, engineers and physicists, though many botanists and agronomists in recent times have waged a bitter rearguard action against the idea and its consequences. In climatic studies, the long history of precipitation/evaporation (P/E) and precipitation/temperature (P/T) ratios of various sorts, from Transeau onwards, marks the continued effort to obtain an index of the usefulness of precipitation.

Far too often such ratios are calculated on an annual basis. We may compare two African localities, Tozi (Singa district) in the Sudan and Mackinnon Road in the arid plains of eastern Kenya. Both have about 28 inches of rain and both probably have around 100 inches annual evaporation, so the overall P/E ratios will be the same. At Tozi the rain is concentrated into less than 4 months, during which it equals or exceeds the evaporation ($P/E \geqslant 1$); at Mackinnon Road the rains are scattered over 8 months, and during these P/E would be about 0·5.

P/T ratios have provided a useful basis for detecting similarities in climate, but they do not relate directly to any specific factor of plant life. No doubt when reliable evaporation data become more generally available, the P/T ratio will cease to have any real interest. The agriculturally important relation between precipitation and water use is not, however, a ratio but a difference, as Thornthwaite[3] seems to have been the first to point out.

In my view the great hope for the future of climatic assessment in tropical Africa lies in the development of the methods for the estimation of water use introduced by Dr. H. L. Penman[4] at Rothamsted about twelve years ago. He concluded theoretically, and then demonstrated practically, that transpiration in a field crop is essentially a physical phenomenon similar to evaporation and governed by energy income and air movement; that consequently given a free supply of water different farm crops will, over periods as long as a week or a fortnight, transpire similar amounts per unit of land area, provided they are level and cover the ground more or less completely, and that this rate is rather less than, but related to, the evaporation rate from an open water surface. He provided also a means of calculating evaporation rates from simple climatic data, in an equation which is reasonably sound theoretically and sufficiently empirical to be applicable in practice. In this country these methods have proved reasonably accurate and workers in some parts of tropical Africa, such as Pereira,[5] seem satisfied, but rates of transpiration higher than evaporation have been reported from Uganda (e.g. by Hutchinson, Manning and Farbrother, 1958[6]). These difficulties appear to arise from an underestimation of the radiation income, which supplies the large amount of energy needed for transpiration. In temperate regions it is not

unreasonable to work from standard tables of the theoretical radiation receipt, in the absence of an atmosphere, based on the geometry of the earth and a solar constant of 1·94 gcal/cm²/min. The figures so obtained appear to underestimate radiation income in tropical latitudes. For example Huxley in Uganda (private communication) has recorded, over short periods and on days when there is a good deal of reflection from clouds, values near ground level in excess of 2 gcal/cm²/min. These difficulties are currently being resolved by direct measurements of radiation, and it seems reasonably certain that we shall ultimately be able to make sufficiently reliable estimates of transpiration from meteorological observations, just as we can in Britain.

With such values it would be possible to assess, week by week, the balance sheet of precipitation and evaporation. We may regard any period as favourable for crop growth during which effective precipitation (allowing for run-off) is greater than or equal to evaporation, or less than evaporation by an amount not exceeding the amount of available water in the soil within the root range of plants. For most annual tropical crops a favourable period of at least twelve weeks is desirable. For crude agronomic purposes, the amount of available water within root range could be taken, in the absence of precise data, as 4 inches on lighter soils and 6 inches on heavier ones (cf. Penman's root constant, taken at 3 inches in this country where a better figure is not available). The actual value turns on factors like depth of root penetration and water-absorbing activity of the crop, and on soil texture and structure, as well as on slope, rainfall pattern and other factors affecting infiltration. In Penman's water-balance calculations it is assumed that no water is lost by run-off, but on unprotected, sloping land in the tropics a considerable allowance may have to be made for such losses. This reinforces the importance of such measures as tie-ridging for the conservation of water.

The use of Penman's methods, modified by current research, could lead to a map of much of tropical Africa indicating the regions which may be expected to experience favourable periods of different lengths in four years out of five; this would become a primary document in tropical agricultural meteorology. The paucity in some areas of even the simple meteorological data required would often be offset by extrapolation over the large areas of fairly uniform conditions which do so much to simplify our comprehension of the tropical parts of Africa.

SOIL MOISTURE RÉGIMES

In the study of crop water relations it is important to take account of the characteristic patterns of the soil moisture régimes of different climatic regions. The calculation of water balance sheets in this country is greatly facilitated by the fact that during the winter the soil profile becomes filled throughout with water, i.e. to field capacity (the amount

of water the soil can hold against gravity). During the winter, when 40 to 60 per cent of the annual rainfall is received, evaporation rates are low (P/E positive and large) so that water accumulates, nearly always to the point of leaching. The crops, therefore, have a considerable accumulated balance to draw on at the start of the season. Events after the start of the growing season may be represented as the irregular development of a soil moisture deficit during the summer when in most years and in most parts of Britain evaporation is greater, and sometimes much greater, than precipitation (P/E negative and often large).

A quite opposite situation occurs in the seasonally arid tropics, where the profile within root range is dried out to wilting point at the end of the growing season, and starts to fill again only at the start of the new season. Consequently the crop season may open with no more than a slender balance, and continues as a running fight between evaporation and transpiration, in which ultimately evaporation gains the upper hand as the rains decline. Under wild vegetation, particularly if it is perennial, the balance is particularly critical, since transpiration begins almost as soon as there is any water to transpire, so that there is no time at the start of the season to accumulate a credit balance of water in the profile, as can be done with annual crops. Under open woodland with annual grass and herbs on the heavy clays at Tozi the seasonal penetration of moisture does not usually extend below 12 inches, whereas under annual cropping it usually reaches 4 feet, representing up to 10 inches of available water, all within root range. Hence a region which is markedly arid for perennial plants may be effectively humid for annual ones. The distribution of the rain in the earlier part of the season is most important for annual cropping: scattered rains on bare soil may do no more than allow precipitation to keep pace with evaporation whereas the same total, in concentrated storms, may allow the accumulation of useful reserves before the crops are sown.

In the wetter tropical forest areas the profile is full through most of the year, but because the vegetation is evergreen and has to bear the load of evaporation for twelve months a year, a relatively slight decline in the monthly receipt of rain, or pronounced irregularity in its distribution, may quite easily lead to serious shortages of water. This is especially likely if the total rainfall is similar to or not much greater than the total evaporation for the year, which must be at least 60 inches in such areas: in these circumstances it is not surprising to find that many of the tree species of the evergreen forest have leathery, sclerophyllous leaves and other alleged adaptations to dry conditions.

In the forest belt, or the wetter parts of the savannah region, the close balance between precipitation and evaporation depends largely on the virtually continuous transpiration of the vegetation. If the vegetation is removed, as in large-scale clearing, water accumulates rapidly in the profile and both run-off (which leads to severe erosion)

and leaching are greatly accelerated. This will lead suddenly, in flat country, to flooding and swamp conditions in valleys and on the lower slopes of the higher ground, and may create a completely unmanageable hydrographic situation. At the same time the leaching and erosion may severely damage the soil. Consequently in wet country large-scale clearing is often dangerous. For such areas a more gradual process of replacement of uneconomic by economic plants will have to be developed, presumably based in the earlier stages on selective thinning of the lower stories of the vegetation and the establishment of shade-tolerant or shade-demanding perennial crops. So far as I know this problem has not hitherto been defined clearly, though it has certainly been encountered.

The quantities of water involved in the moisture balances will depend on soil texture and profile depth, but these factors will not greatly affect the general pattern, except that on sands, the efficiency of water use seems to be higher than on clays. On the sands, losses by run-off are lower than on clays while the lower field capacity of the sands enables a given quantity of water to penetrate to a greater depth than on clays, and so protects more of it against surface evaporation. This was very clearly pointed out by the late Dr. John Smith[7] in his work on the distribution of tree species in the Sudan. He summarized his conclusions by saying that a tree species which requires $3x$ inches of rain on clay soils will require only $2x$ inches on the sands.

THE SPECIFICATION OF AGRICULTURAL POSSIBILITIES

So far we have considered only a relatively simple aspect of the over-all problem—the determination of the probable length of the period favourable to growth. Even when we have maps showing broadly the distribution of areas of differing potential, in terms of water relations, we have still to decide what crops, and what systems of improved agriculture, are appropriate to or possible in the different areas. At this stage we have to consider the ecological requirements of different types of agriculture and of different crops. Now in this field we have, in the present stage of knowledge, to rely largely on qualitative and partly intuitive judgments, since it is very seldom possible to put reliable numerical values on the environmental needs. In the majority of cases the agricultural prescriptions have to be tested on the spot by suitable programmes of agronomic experimentation and practical trial. It is not possible to define an agricultural system on climatological information alone. Where the problem is essentially one of extending an already successful system or crop into a similar and contiguous area, the operation may be essentially administrative. Most of the foreseeable developments in tropical African agriculture are, however, not of this kind.

Possible agricultural systems fall into three groups—plantation production, using perennial species of plants, often trees; arable production,

using annuals, with or without associated animal production; and extensive pasturage or ranching based on the wild vegetation. The last is usually all that can be done with regions in which the favourable period for plant growth is less than twelve weeks; but even there it requires dry-season water supplies and fodder, and is in practice most widely found in the pastoral husbandry of nomadic peoples. In the Sudan the nomad herds graze during the summer in the dry north on the ephemeral vegetation of the southern fringes of the desert; as feed and water become scarce they move southwards, following the retreating rains, often for hundreds of miles, to the margins of the swamps or the foot-hills of the mountains.[8] This system is possible only because the isohyets are closely spaced, so that the distance from the 10-inch to the 40-inch isohyets can be traversed by a slowly moving herd in the time available. Even so there is severe pressure on grazing in the neighbourhood of the temporary and permanent water supplies.

The distinction between the perennial and annual systems of cropping depends on whether or not the favourable period is long enough to accommodate the normal cycle of growth of an appropriate perennial species or variety. Perennials may be divided formally into deciduous and evergreen species, but the distinction is very flexible, since a species or variety which loses all its leaves in a seasonally arid region may produce a continuous series of leaves, or of flushes of leaves, overlapping in time, in a wetter one. The key question is the minimum length of favourable season which will permit both economic yield and normal resumption of growth in the next season. Within a species this may vary widely between different varieties; and between species the requirements vary from 5–6 months in tung and wattle at relatively high altitudes where the dry season is cool to something like 11 or 12 months for low-country forest species like teak, and will also be affected by the temperature régime.

Arable systems of cropping are very diverse. With no more than 12 favourable weeks, the cropping may be restricted to a single species, as in the extensive partly mechanized grain-sorghum production of the drier parts of the central Sudan, except in so far as water can be accumulated, on soils of high-storage capacity, by bare fallowing. A rather longer period, say 16 to 18 weeks, gives time for the handling of a much wider range of species. The choice of species is complicated by effects of temperature and varietal differences. These may be exemplified by two crops, the groundnut and the cereal sorghum.

There are two principal botanical and agronomic types of cultivated groundnuts, the upright bunch forms, and the spreading bunch and prostrate forms. They differ in many respects, including season length to maturity. In the Sudan region of Africa generally, at altitudes up to 1500 feet or so, the upright bunch forms mature in 90–95 days from sowing and the others in 120–150 days, depending on variety. In East Africa, at 3000 feet, the upright bunch forms require 105–110

days; and in the central Transvaal at about 4000 feet, they need 120 to 130 days. These differences appear to depend largely on temperature; they do not depend on day length.

Among the cultivated sorghums of the Sudan a vast range of forms is found, adapted to all conditions from the northern limits of rain-fed agriculture to the margins of the swamps; from 15 inches of rain to 45 inches.

It is consequently quite impossible to make any general statement about the climatic requirements of groundnuts or sorghum: it is not even possible to make more than the crudest of statements about specific varieties. Experience with maize, sesame and many other crops reinforces this conclusion. How much more dangerous is it therefore to imply any constancy of ecological behaviour in crop plants as a whole, as we tend to do in using concepts like that of threshold temperature. Ecologically, there is no such thing as "the plant"; and agronomically and physiologically there is no such thing as "the species". The agronomist can do no more than make an intelligent and wide selection of possibilities and then test them imaginatively by direct experimentation on the ground during a number of seasons.

I would like now to pass briefly in review a number of other related problems of African agricultural climatology. Where irrigation is possible with water of suitable quality, agriculture can be liberated to an extent from the bonds of water relations. But the application of water is limited, in most irrigation schemes, by the designed capacity of the distribution system. Hence, though evaporation will vary from season to season, the application of water cannot be increased in years when evaporation is high, while water is wasted when it is low. Now in the Gezira cotton irrigation scheme in the Sudan, it was observed, over a number of years, that in spite of the irrigation there was a close and calculable positive relation (the pre-sowing rains equation), over the scheme as a whole, between the small amount of rain which fell before the cotton was sown and the final yield of the crop.[9] The actual quantity of water received in pre-sowing rains is too small to affect the water balance of the season and no direct soil effect can be found. This relationship has not persisted in more recent years, so that the equation, which looked like a valuable method of crop forecasting, is said to have broken down. It seems possible that the basic relation is really a negative one between the evaporation rates of the crop season and the yield of the crop. In some seasons high pre-sowing rains may well have been associated with low evaporation rates later on and vice versa. Meteorological data exist from which the trends of evaporation rate, if not the exact values, could be calculated by Penman's methods, and we at Reading have recently programmed the calculations for an electronic computer. This would permit an analysis of the yield–

evaporation relation, particularly as detailed crop physiological information is available year by year for the last twenty years. So far no work has been published on this question.

A classic problem of African climatology concerns the influence on rainfall of large bodies of open water. The engineer Schwarz proposed, many years ago, the diversion of part of the waters of the Zambesi to form a new inland lake in the arid Kalahari region, on the grounds that this would increase the rainfall there. Against this it may be argued that Lake Victoria, which is much the same size and shape as Ireland, does not appear to influence the regional climate for more than sixty miles from its shores, and that only in a northwesterly direction, along the track of the rain-bearing winds. Is this conclusion applicable to the Kalahari? Or would the effects of what looks like a drop in the ocean be more significant in an arid region? Coupled with this is the old problem of forests and rainfall. We would expect forests to occur only where rainfall is sufficient; but it is said that the rainfall of southern Abyssinia declined at about the time when the major clearing of the Kenya highlands was completed. Does the replacement of forest by grassland reduce stream flow? Those who think it does are vocal and persuasive. Experimental catchment gauging has only started in east Africa in recent years, in the capable hands of Dr. Pereira,[10] who seems to conclude so far that Penman is right and that transpiration per acre is much the same whatever species the water is passing through. Many people have seen rain begin to fall from a seeded cumulus cloud; but can the artificial induction of rainfall change climate? And even if it can, how does one prove it in a period of less than ten or twenty years?

The light factor of the environment presents another group of problems. Cocoa in the Gold Coast is traditionally grown in the shade of the forest; and this is usually explained by saying that cocoa is an understory species in its home in the Amazon forests. Recently Cunningham and Lamb, of the West African Cocoa Research Institute in Ghana, have published the results of experiments which show that provided pests and diseases are controlled, and the trees are adequately supplied with nutrients, cocoa will grow far more vigorously and yield up to four times as much in the open as in shade.[11] This reinforces a view which becomes inescapable in agricultural biology: the climatic and other environmental conditions of the ecological home of a species, where it is in fierce competition with others for survival, are virtually never optimal for its growth or yield in pure stand. Species grow in nature not where they are physiologically best suited, but where other species are even less well suited: not where they like but where they must.

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The Changing Form of London's Heat-island

T. J. CHANDLER

THIS IS AN ACCOUNT of a co-operative study of London's climate: of an investigation made mainly by secondary schools and training colleges working together in a scheme organized by the geography department of University College, London. Initially the survey was known as the Lea Valley Climatological Survey and its work was limited to the Lea Valley district of northeast London. This investigation continued for more than two years but it soon became clear that one could not fully understand the climate of the Lea Valley district, much less interpret the climate of the whole city, from a study of only one sector of the urban area. For this reason, coverage has recently been extended to the whole London district, and the enquiry has been renamed the London Climatological Survey.

Climatological readings have been obtained from two sources: a mobile survey using a car equipped with electrical resistance thermometers, and a network of thirty-nine climatological stations taking twice-daily records. Not all of these stations were ready when the survey began in the autumn of 1958 and the total was built up over several months. The two parts of the investigation provided complementary linear and areal pictures of the thermal and humidity characteristics of London's climate. Some findings of the mobile investigation have been published;[1] this paper presents an account of the fixed-station survey, its purpose, methods and some of its conclusions.

Previous investigations of London's climate have frequently been limited by the relative sparseness of data, for even today, there are records from only sixteen official stations within the 722 square miles of the urban area. Again, few workers have considered the spatial, distributional aspects of the climate. Amongst others, Luke Howard and E. G. Bilham have each discussed the degree to which the central districts of London are warmer than the surrounding rural districts.[2] Luke Howard's work was based upon a series of simple instrumental measures of temperature taken between 1806 and 1830 at Somerset House and successive sites in what is now northeast London but was, in 1833, open country beyond the city margin. Unfortunately, his

➤ Mr. Chandler, a lecturer in geography at University College, London, contributed this paper to a discussion on the teaching of meteorology and climatology in schools during the Annual Conference of the Association on 2nd January, 1961. He wishes to acknowledge with gratitude the most generous help of many educational bodies and private persons who have purchased and maintained climatological stations. He is also indebted to the Director General of the Meteorological Office for permission to consult records. The research generally has been greatly aided by facilities provided at University College, London.

instruments were almost certainly inaccurate and his exposures were far from standard. E. G. Bilham, on the other hand, compared the official records of central, suburban and rural climatological stations. These showed only small differences in maximum temperatures, particularly in summer, although differences in average monthly minimum temperatures were appreciable, there being positive temperature anomalies in the central districts averaging 2·5°F for the whole year, and in suburban districts, 1°F. The differences between Westminster and Wisley (Surrey) mean monthly minimum temperatures were greater than 3°F from May to October inclusive.

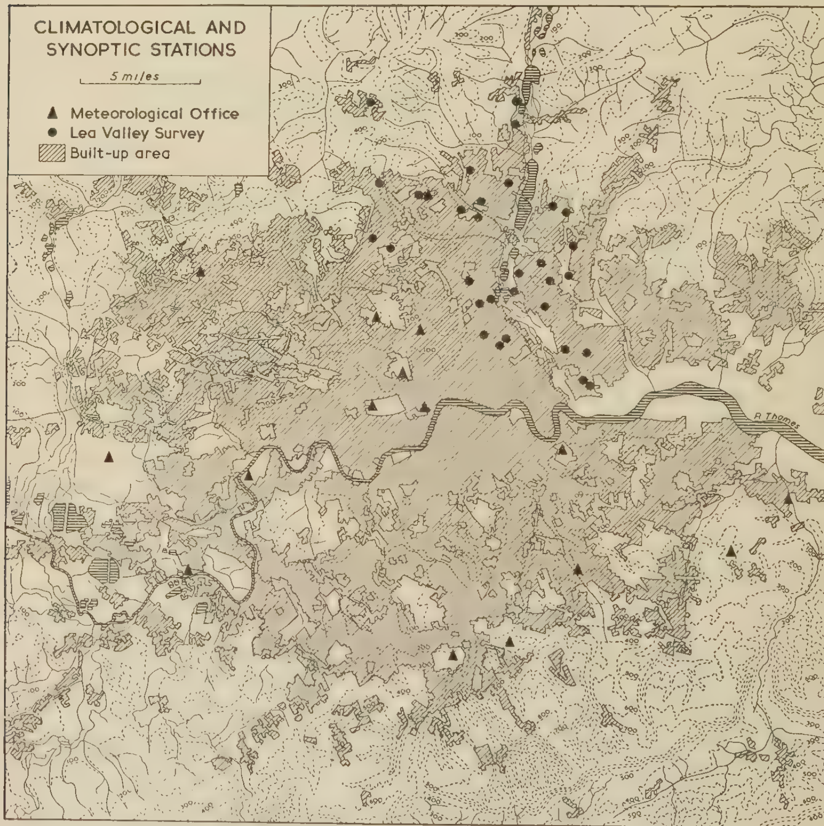

Fig. 1.

Such studies are sufficient to show the main outlines of the city's climate but the records of official climatological stations are too sparse to permit a detailed areal study of the man-modified climate in which some eight million people live and work. In order to make such a study, the first need was for readings from a close network of recording stations. To attempt this over the entire city would have involved a tremendous central organization with uncertain academic returns and for this

reason, the Survey was restricted in the first instance to the Lea Valley district of the northeast. A recent extension to the whole of London has been made possible only by a selection of sites suggested by findings in this smaller area.

Within the lower Lea Valley district, and extending from a northern boundary between Welwyn and Bishop's Stortford, thence southward to the Thames, all secondary schools—grammar, modern, technical, comprehensive and private—training colleges and technical colleges were contacted with a view to joining with each other and with the geography department of University College, London, in a survey of the local climate. More than one hundred schools replied expressing interest in the scheme; these were visited and details of the scheme, including instrument and site requirements, were explained to headmasters and staff. The basic equipment (frequently exceeded by subsequent purchases and constructions) necessary for participation consisted of Meteorological Office pattern, National Physical Laboratory certificated, maximum, minimum, wet and dry bulb thermometers, a Stevenson screen and a rain gauge. The cost of these was frequently prohibitive to schools and invariably it raised financial problems. For this reason, one school was persuaded to make a considerable number of standard Stevenson screens for a very moderate price.

Some schools found themselves unable to afford the expense, some had no suitable site for the climatological station, and for these or other reasons, the potential membership of the Survey was reduced to little more than fifty. Each school presented its own set of problems and, at some schools, these remain unresolved even today: there are still twelve schools in the lower Lea Valley district hoping to join the scheme when their own local difficulties have been overcome. Certain problems were, however, fairly general.

At almost every school, there was the initial difficulty of maintaining 0900 and 1400 GMT readings not only during weekdays in term, but also at week-ends and during holidays. In most cases continuity was achieved by a rota of pupils or by the assistance of trustworthy caretakers or gardeners. But occasionally there was no solution to the problem, and for this reason, monthly analyses of the readings for members of the Survey were made on both a five- and seven-day basis. Analyses of each station's readings are made at the geography department of University College and the results are duplicated and distributed to all participants. Thus, in addition to their own readings, schools obtain monthly records from a considerable number of other stations in a small region known to the pupils. Base maps of the area are also supplied for the construction by schools of distribution maps showing mean and extreme monthly temperatures, humidities and rainfall.

Thermometers are read to the nearest tenth of a degree and, before readings began, it was anticipated that some schools might find it

difficult to achieve this degree of accuracy. There have of course been occasional mistakes—as there are in all such records not excluding those of official climatological stations, but their number has been remarkably small. The commonest error is a misreading of five or ten degrees and this can easily be discovered and corrected by comparison with nearby stations. Masters have also co-operated in this respect by making periodic checks on the readings.

SOME FINDINGS OF THE INVESTIGATION

The Lea Valley Survey, by its co-operation between school geography and science teachers and a university department of geography, has yielded a large body of material for detailed analysis. This has been used by schools in their teaching of geography, physics and mathematics but the results of the Survey are also of considerable academic value: a number of typical distribution maps will be used to illustrate this.

The maps are based both upon the readings of schools and colleges in the lower Lea Valley and upon records of official Air Ministry synoptic and climatological stations within the London district. Figure 1 shows the distribution of these stations and explains why the maps which follow are more detailed in northeast London than in the remainder of the built-up area. With the extension of the Survey, it is hoped that the general inferences, which are often as much as one can offer for a considerable part of London, will be replaced by detailed knowledge. However, certain aspects of London's climate are clearly indicated by the information now available. The distribution maps which follow have been drawn on the basis of these records, guided also where the network is open, by readings from relevant day or night temperature traverses, using electrical resistance thermometers mounted on the survey car.

Perhaps the most distinctive feature of London's local climate is the mass of warm air, a feature of town climates known as a "heat-island", which commonly lies within and above the built-up area. As mentioned above, temperatures are normally higher in the central districts than in the rural areas around the city and the anomaly is usually greatest by night. Although there is a general tendency for greater contrasts of minimum temperature during summer, differences of more than 8°F occur in all seasons. During 1959, for instance, there were 76 occasions when the difference in minimum temperatures at Kensington and Bayfordbury, Hertfordshire, was 8°F or more, although the median value was only 4°F and extreme values were −3°F and 16°F. The median difference in maximum daily temperatures at these two stations was 2°F, varying between −3°F and 8°F (Fig. 2). Bayfordbury is 140 feet higher than Kensington and we should expect a difference due to altitude under normal lapse-rate conditions of about 0·5°F.

The reason for these differences is by no means easy to understand, and the cause is no doubt multiple. The heat-island is the result of

many factors, including heat reflection and back radiation from the pollution haze above the city, back-radiation of terrestrial radiation by tall buildings, the retention of heat by the structures of the urban area, differences in heat loss by evaporation, and the heat of fuel combustion in homes and factories and by vehicles. The variety of meteorological elements influencing the degree and form of such heating is also considerable; these include wind speed and direction, cloud amounts, humidities and accumulated temperatures during the preceding period. It is hoped that the Survey will help to solve some of the puzzling features not only of London's climate, but of urban climates in general.

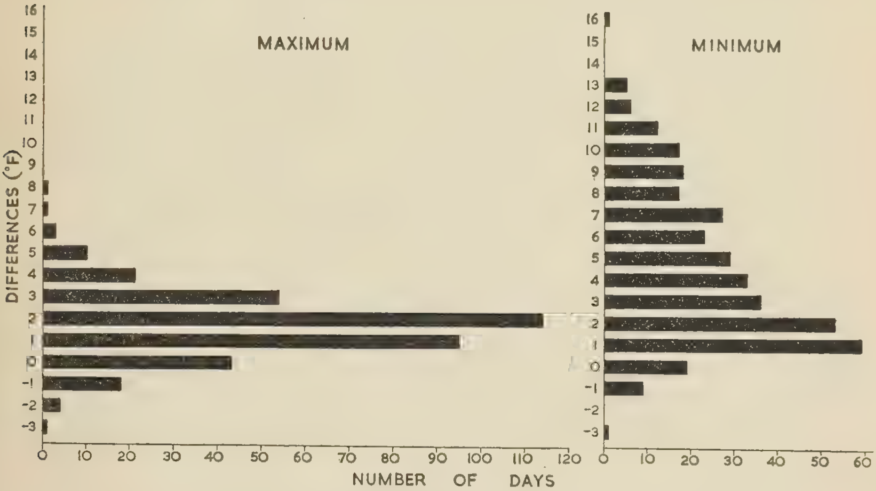

Fig. 2.—Differences in maximum and minimum temperatures, Kensington–Bayfordbury, 1959.

Some of the most interesting results of the Survey concern the form of London's heat-island, more particularly as it is influenced by the time of day, wind speed and wind direction. During daytime, London is normally little warmer than its surroundings and the margins of the warmer air are rarely well defined. On certain occasions, the anomaly is negative, Bayfordbury, a rural station, being warmer than Kensington. Many such instances can be explained in terms of the location of fronts, or local differences in cloud amounts (perhaps for even a very short period) or fog density, but others are more difficult to understand. This same feature in other cities has been accredited to a number of factors, but none of the explanations is truly comprehensive.

Figure 3 shows a fairly typical distribution of maximum daily temperature. Here, as in all subsequent distribution maps, continuous lines are used only where they can be drawn with precision; elsewhere, where records are more sparse, broken lines indicate some measure of uncertainty, not usually in the general run of the isotherms, but in their precise location. Even in these areas, however, the possible margin

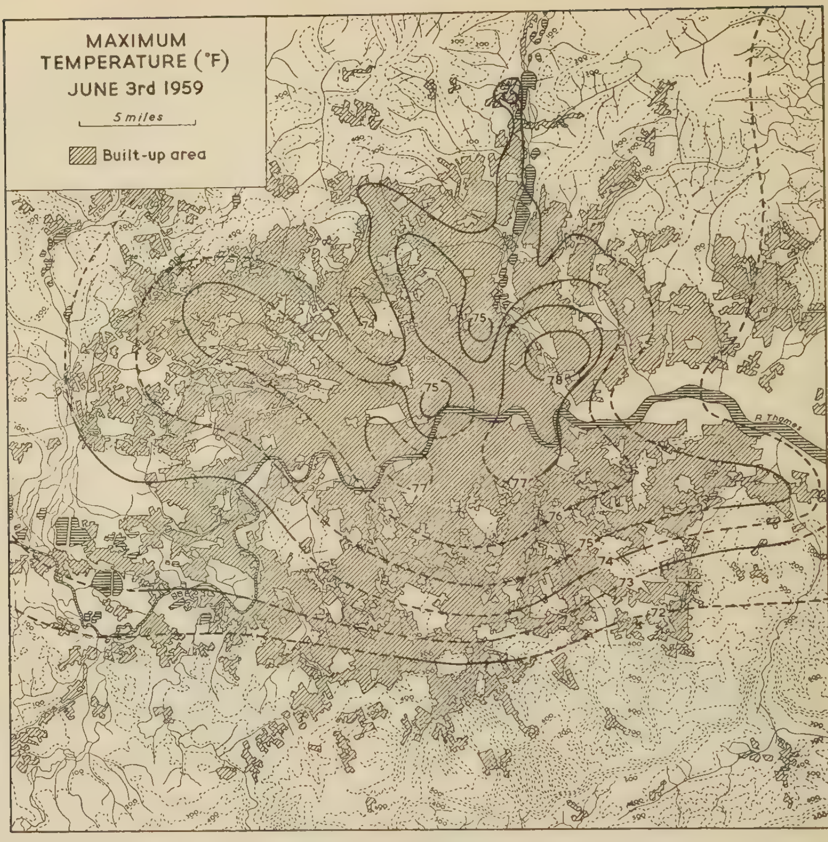

Fig. 3.

of error is commonly small. On Wednesday, 3rd June, 1959, England lay near the centre of a col between an anticyclone over Germany and an extensive Azores "high". Pressure fell northward to a deep depression over Iceland and southward to a much shallower depression over North Africa. The day was sunny, never more than half the sky being obscured by cumulus clouds which were of no great vertical development. Winds of about ten knots (recorded at London airport on the western fringes of the city) backed from northwest to southwest during the morning, in which direction they remained almost constant for the remainder of the day.

The highest maximum temperatures, above 77°F, were recorded in the Lewisham, Deptford, Stepney, Poplar and West Ham districts of east London, that is on the leeward side of the city, and also in a smaller region of Kensington and Chelsea; elsewhere, maximum temperatures ranged between 74° and 76°F. Several features of the distribution are worthy of notice. First, the weakly developed and rather irregular heat-island roughly coincident with the built-up area of London. The map almost certainly fails to portray adequately

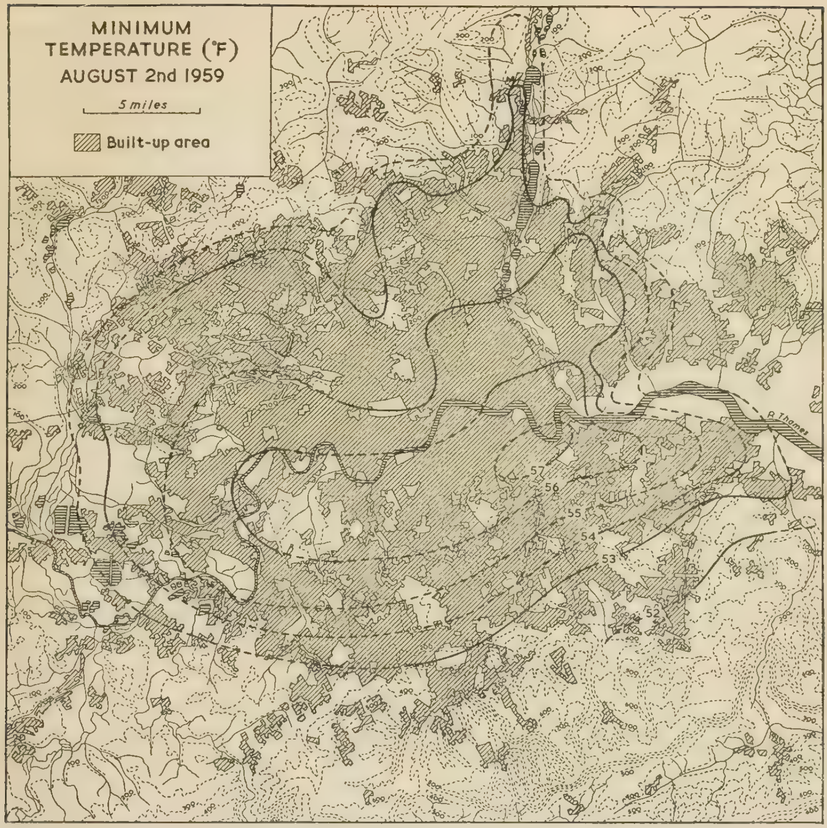

Fig. 4.

the detailed regional pattern of temperature but the characteristic daytime complexity, reflecting the cellular structure of the city, is brought out in northeast London with its closer network of climatological stations. The diffused form of the heat-island margins is also typical of daytime wind speeds of ten knots or more. Thermal gradients near the city margins are everywhere gentler than with light winds, but another result seems to be the warming of areas well to the lee of the city. Increased mechanical and thermal turbulence induced in winds of ten knots or more are likely to lead to the warming of a deep boundary layer as it crosses the city, giving higher temperatures in rural areas beyond the city than on its windward side. On this particular day, large areas north and northeast of London had temperatures of more than 74°F—areas with elevations above those in south and southwest London where temperatures were below 74°F.

The distribution of maximum temperatures on 3rd June, 1959, with its small urban–rural temperature contrasts and a generally complex pattern of isotherms, is typical of daytime thermal conditions in cities. There follows a selection of occasions taken to illustrate what the survey has shown to be representative of certain night-time conditions. The

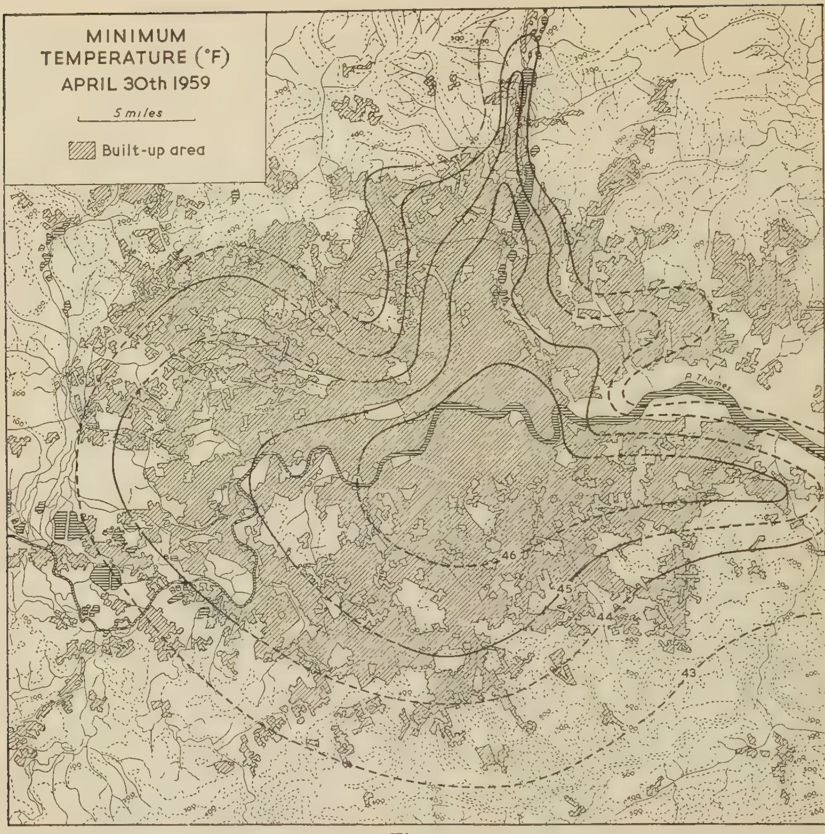

Fig. 5.

distribution of minimum temperatures for the night of 1–2nd August, 1959, for instance, shows the close relationship between the intensity of cloud cover and the size of the urban–rural temperature contrast. During this night, northeasterly winds of about five knots blew around the eastern margins of an anticyclone centred southwest of Ireland and there was an almost complete cover of stratus and stratocumulus cloud whose base lowered from about 1800 feet at midnight to little above 500 feet at dawn on the 2nd. Figure 4 shows the results of these conditions. In spite of the gentle breezes, the cloud bank above the city intercepted much of the long-wave radiation from the ground and thereby reduced the contrast in night-time heat losses between rural and urban areas. The urban–rural temperature differences were therefore considerably less than under clear-sky conditions, reaching an extreme value of only five degrees in the early hours of the 2nd. The pattern of the isotherms is also interesting: more especially the displacement of the highest temperatures to the Greenwich and Deptford districts of southeast London. Thus, apart from a sharp rise of temperature of about 1°F near the edge of the built-up area, thermal gradients were steep only on the southeast (leeward) side of the city.

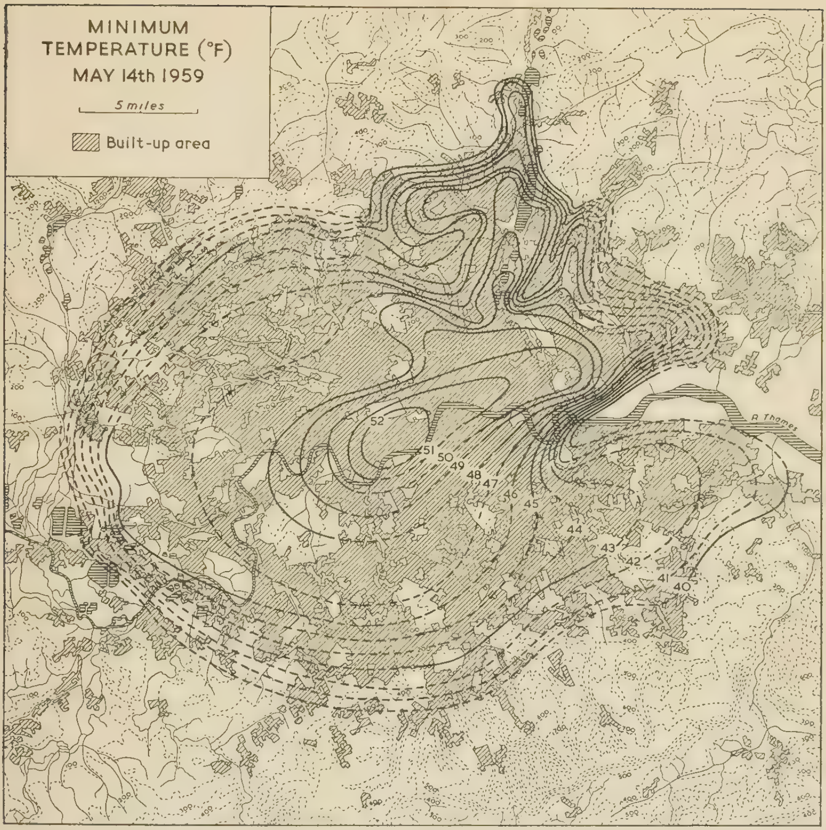

Fig. 6.

This asymmetric distribution seems to be a common feature of nights with light winds.

A dense cloud cover is seen to reduce the intensity of the heat-island. The significance of wind speed can be illustrated in a comparison of two spring nights. On one, 29–30th April, 1959, skies were clear except for a high, thin veil of cirrus, but winds were fresh; on the second night, 13–14th May, 1959, cloudless skies were this time associated with a light air of less than 4 knots. Differences in the intensity and form of London's heat-island on the two nights are striking (Figs. 5 and 6).

During the night of 29–30th April, Britain lay on the southeastern side of a ridge of high pressure from southwest of Ireland northeast to southern Norway. Pressure fell sharply toward a secondary depression over Belgium. Northerly winds of about 18 knots blew during the night and, in association with deep and active turbulence in the boundary layer near the earth's surface, the city's warmth was diffused both laterally and vertically. The intensity of the heat-island on this night was consequently small—a matter of four degrees only. (The Survey has, in fact, shown that the thermal effect of the city is almost entirely eliminated by wind speeds greater than about 22 knots. This

compares with 16 knots given by Mey (and quoted by Kratzer) for Bremen[3] and 8–13 knots given by Parry for Reading.[4]) As on 3rd June, when winds were also strong, thermal gradients from the centre were strongest on the windward side of the heat-island.

The very close relationship between the pattern of isotherms and the form of the city is also noticeable. The correspondence is shown best in areas of the northeast where we can draw isotherms with great accuracy. Ribbon development along terraces on the western side of the Lea Valley is mirrored in a long tongue of warm air northward to Cheshunt. On the other hand, the wedge of cold air projecting inward from the northwest is related to elevation as well as to the open nature of the area between Arkley and Hampstead Heath. There is every reason to suppose that the intimate relationship between the form of the city and its heat-island as displayed in the northeast, Lea Valley, district is just as close in other parts of London, though this cannot at present be demonstrated. The isotherm patterns will no doubt be complex in those parts of London, such as the west and southwest, where there is a more detailed intermingling of built-up areas and open spaces. Temperature traverses in these areas have in fact illustrated the influence of such open spaces as Hyde Park, Kew Gardens and Hounslow Heath upon local temperatures and humidities.

Contrasted with the form of the heat-island early on 30th April is that revealed by the distribution of minimum temperatures on 14th May, 1959. On the latter occasion, light northeasterly to northerly winds of less than four knots and clear skies were associated with a deep anticyclone covering most of Great Britain and the Continent. These conditions allowed the full interplay of the several factors contributing to an urban–rural temperature contrast. An intense heat-island with steep thermal gradients paralleling the edge of the built-up area was the result. In Kensington, minimum temperatures did not fall below 52°F, twelve degrees higher than in the rural districts around the city. The correspondence between the intensity of urban development and the degree of warming is very remarkable, both on the regional and very local scale, with the development of sharp temperature contrasts around and within the city. Cool air above the open, low-lying and often marshy grounds of Thameside below Woolwich was separated from warm air above the closely built districts of West and East Ham by a thermal gradient far sharper than most major fronts and it is hardly surprising that the Survey has also indicated the existence of thermally induced local winds, similar in genesis to sea-breezes, around the margins of London. These winds would seem to move inward to the warmer central districts in a series of pulses, quickly losing speed through friction with the buildings. Between each series of movements, thermal gradients are built up again. In this context, the steepening of the temperature gradient around a central 'peak' of the heat-island may mark the inner limit of such movements—although this inner zone

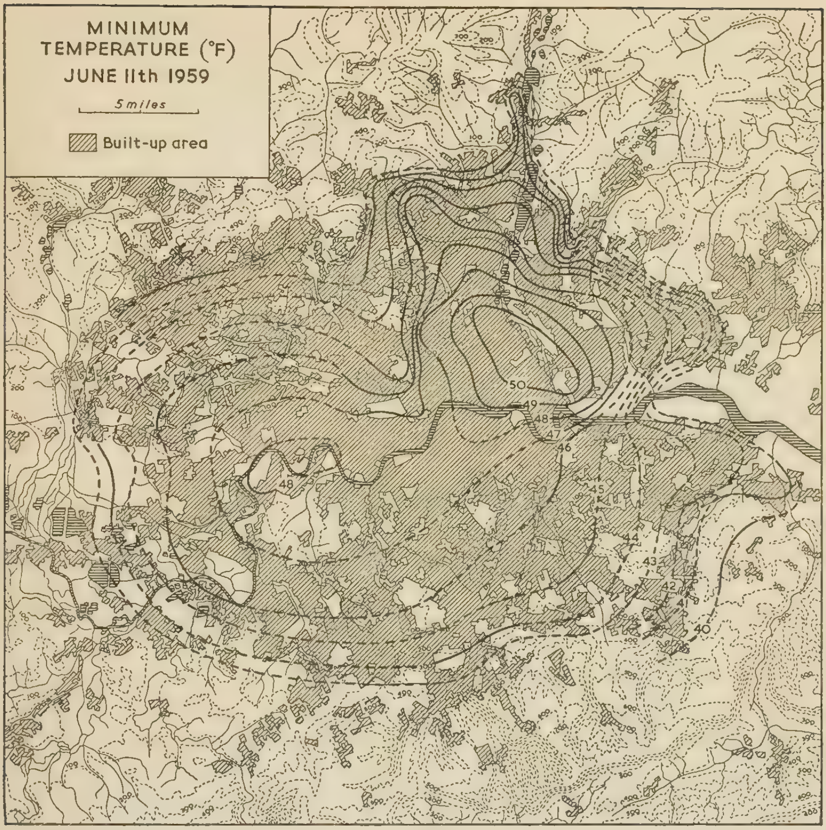

Fig. 7.

of warm air also seems to coincide with the area of closest urban development, an area with very few open spaces. Such local winds are almost certainly shallow features and can only occur when regional winds are light. Owing to the reduction of near-surface windspeeds on the leeward side of the city, this type of wind is more frequently found here than along windward margins.

Turning to the effect of wind direction upon the form of London's heat-island, the influence is very well illustrated by conditions during the night of 10–11th June, 1959. On this occasion, a ridge of high pressure covering most of Great Britain extended northward from an anticyclone centred west of Brittany. A weak warm front over the Irish Sea had no immediate influence upon the weather of southeast England where skies were only partially covered by a few fragments of stratocumulus and cirrus. Winds of 2 to 5 knots blew from the west. The result of these two sets of conditions, fairly clear skies and light winds, was to create a well-developed heat-island of the order of 10°F, with the highest temperatures appreciably displaced towards the eastern districts of the city where marginal temperature gradients were consequently steepest (Fig. 7). This is a feature we have already noticed to

be characteristically associated with light winds. A smaller centre of local heating, though there may well be others unrecorded, lay in the Richmond district of west London.

The asymmetry of the heat-island on this occasion is particularly well developed. This may be partly owing to the orientation of the wind along the line of the Thames Valley. Also of significance may be the very intense urban development, with a close spacing of tall terrace houses, in the Shoreditch, Bethnal Green, Stepney, Southwark, Bermondsey and Poplar districts of east-central London. The building fabric in these areas must act as a considerable reservoir of heat, stored during the day and in summer, and released during the night to maintain higher temperatures than in more open parts of the city, such as the southwest.

CONCLUSION

These, then, are some of the findings of the London Climatological Survey. It can be fairly said that this scheme is one of the most intense studies made of urban climates, and certainly the first of its kind in London. It would not have been possible, however, without the most generous assistance and close co-operation of geography departments in schools, technical and training colleges. The Survey has added appreciably to our knowledge of London's climate but, like many scientific investigations, it has also brought to light new problems. Among these are the significance of regional changes in the intensity and fabric of urban development, and the nature of local winds induced around the margins of the heat-island. These and other questions cannot be answered until we have more readings from areas of west and south London where records are at present sparse: these we hope to obtain by the extension of the Survey now beginning.

There are many geographical and general educational advantages to be obtained from the maintenance of a school climatological station[5] whose value is, however, very appreciably enhanced when it is one of a number of such stations linked in a scheme of academic interest. Several schools in Great Britain have climatological stations officially recognized by the Meteorological Office to whom they send regular daily readings; others are members of Mr. Keith Berry's "Schools' Meteorological Scheme",[6] but perhaps the more local region, known to the pupils, offers the best basis for geographical study. Certainly it is one field of investigation where schools, properly equipped and organized, can do a great deal of practical work, useful to both themselves and the subject of geography.

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[5] Some of these are mentioned by P. Alun Jones in "Meteorology in schools", *Geography*, vol. xxxix, 1954, pp. 182–8; by W. G. V. Balchin in "Local climatic studies for schools", *Geography*, vol. xxxiii, 1948, pp. 128–36; and by A. A. Miller in "Microclimatology: a new approach to the teaching of climate", *Geography*, vol. xxii, 1937, pp. 100–4.

[6] The scheme is explained by Keith Berry in "The Schools' Meteorological Scheme", *Weather*, vol. xv, 1960, pp. 149–52. Enquiries should be sent to Mr. K. Berry, West Cliff Secondary School, Whitby, Yorkshire.

Meteorology and Climatology in Schools

The Lea Valley Climatological Survey

R. H. C. CARR-GREGG

"WRITE AN ESSAY on the character and effects of stability and instability in the atmosphere." . . . "What importance do you attach to the study of air masses? Justify your answer." . . . "Describe the climate of any small area, e.g. that around your school, illustrating your answer with data obtained from an actual weather station." . . . These questions, taken at random from recent G.C.E. Advanced Level geography papers, reflect the importance which the examiners place on meteorological as well as climatological studies in school geography courses. Even at Ordinary Level questions on a simple weather chart are regularly set by many examining boards.

It is axiomatic that "there is no geography without climate and there is no climate without weather" and it is evident that young geographers will not get very far in their study of climates without some basic understanding of the elements of meteorology. It is equally obvious, of course, that they cannot get very far in meteorology without some basic understanding of the elements of physics—and there are many teachers who maintain with some justification that the observation and analysis of weather phenomena properly belong to the province of the science department. It may be for this reason that, in some schools, instruction in meteorology may fall between two stools and be neglected. In how many schools is practical work in meteorology regularly organized as an integral part of a syllabus? And how often are the

➤ Mr. Carr-Gregg, senior geography master at Cheshunt Grammar School, contributed this paper to a discussion on the teaching of meteorology and climatology in schools during the Annual Conference of the Association on 2nd January, 1961.

results accurate enough and consistent enough to be worth subjecting to analysis and discussion in class? How often are they of any real educational value at all? And yet, to quote from a report issued some years ago by a distinguished panel of meteorologists, "it is as unrealistic and unsound to teach meteorology without observation as it is to attempt to teach map-reading without allowing the pupils to use maps in the field". Few teachers would dissent from the view that regular observation, recording and analysis of weather phenomena are not only valuable in themselves but are vital to a proper understanding of the physical principles which they reflect. To this end the participation of schools in a scheme of observation such as that provided by the Lea Valley Climatological Survey can be most valuable and stimulating. I have been asked to comment briefly on this Survey as it has affected the work in my own school and I hope I may be forgiven for the inevitably personal nature of my remarks.

There can be very few schools which do not possess (or have not, at some time, possessed) a thermometer screen of some description and it is traditionally the job of the geography department to maintain the instruments it contains and to organize the observations, but the maintenance and organization are, all too often, a somewhat sporadic and unco-ordinated business from which little of real value is achieved.

We, too, owned a Stevenson screen before we ever heard of the Lea Valley Survey—and a curious piece of equipment it was! A small home-made box with single louvres, containing an inaccurate Six's thermometer, a hygrometer which was invariably dry and a rain gauge jammed immovably in the roof! No doubt, it had performed a useful function once upon a time but when Mr. Chandler first announced his intention of calling on us in connection with the Survey* and we went to look for our screen, we found it leaning against a wall with a broken leg. Apparently, it had been knocked down by the motor-mower some weeks previously and no one had seen fit to report the fact. So much for our organization at this time. However, all this changed very quickly when Mr. Chandler came to see us. By a mixture of reproachfulness, flattery and infectious enthusiasm, he soon had us building a brand-new screen to Met. Office specification and equipping it with N.P.L. certificated instruments obtained at a special discount (always a winner with the school bursar). He came and talked to the sixth form about the Survey. He came again and talked to the Geographical Society, and what was even more important, he came and talked to the headmaster, and even persuaded him that the new Stevenson screen would lend aesthetic interest to the sacred lawns of the school garden and that there was no conceivable reason why the turf should suffer from the routine twice-daily visitation. Actually, not a blade of grass has grown in front of the screen for the past two years—but one is sure that even the headmaster would agree that a bare patch on the lawn is

* See the foregoing article, p. 295.

a small enough price to pay for the keen interest which has been aroused in the corps of observers responsible for it.

This interest has been directly due to the fact that, having agreed to take part in the Survey, we were *compelled* to organize an efficient and reliable system of accurate, continuous observing and recording—and herein, we would suggest, lies the greatest value of belonging to such a scheme as the Lea Valley Survey. The work has simply *got* to be done, and done properly, because, as part of a scheme of practical and important research, it has a point and a purpose. If we fail to do our bit, then to some extent the scheme itself fails. This is something that most children can understand and appreciate. To feel that they are a small but vital part of a scheme which is not only beyond the geography room but beyond their own school—to realize that other people are making the same observations at the same time for the same purpose. This gives a sense of importance and responsibility and a feeling that the job is worth while, even on a wet Sunday morning.

To achieve an accurate enough standard, the first essential was to get together a small group of keen, capable, thoroughly instructed observers, some of whom would have to live close enough to the school to carry on the work over week-ends and during the holidays. One should emphasize the importance of this "thorough instruction". It is quite certain that any scheme of continuous recording of weather observations will lose all its point educationally, is likely to lead to gross errors and will eventually fail through sheer lack of interest if the work is done mechanically, without real understanding of the processes involved and of the reasons for doing it at all. So for a few lessons the sixth-form syllabus was shelved while we dipped conscientiously into the *Observers' Handbook* and eventually drew up a set of "Instructions for Weathermen", which, in its initial form, ran into five closely typed sheets of foolscap. This had to be thoroughly absorbed and understood by anyone who wished to join the observing rota. The "Instructions" have now been reduced to three pages but they still take quite a lot of digesting, even by sixth-formers, and further instruction, both in and out of the classroom, is essential if the schoolboy observer is really to understand what he is doing. In this connection it is interesting to hear that one North London school actually runs a "training station" in addition to the main one. This consists of a home-made screen equipped with slightly cheaper instruments and all observers have to spend a probationary period of two months in training before being permitted to join the regular team.

It is surely hardly worth running a weather station at all if one cannot expect reasonably accurate and careful results and this inevitably involves a lot of hard work and a considerable amount of time. As a colleague in another school has written: "I have found that the Lea Valley Scheme has repaid me in enthusiasm from the boys, but you

get out of any scheme as much as you put into it." However, it is not always necessary for a member of the staff to do all the work himself; in fact, it is obviously undesirable that he should. In our case, it became obvious quite early on that one boy, of no great talent academically, was becoming fanatically devoted to the Stevenson screen and was even observed polishing the rain gauge with Brasso. He was automatically made Chief Observer, re-christened "Jupiter", and proceeded to organize the observing rota with great zeal and efficiency. He wrote up the "Weather Notes" for the School Magazine and became responsible for training and testing the younger members of the school Scout Troop for their "Weatherman" badges. It seems that there very often is at least one boy or girl with this kind of aptitude, who, if suitably encouraged, can be trusted to do routine jobs well and to set an example of keenness and accuracy which is much more valuable than the precepts of a member of the teaching staff. It is fair to claim that a properly organized weather station does something to train those who run it, not only in the importance of care and attention to detail, but also in responsibility and reliability.

From the start of our regular recording in May, 1958, the 0900 GMT observations have been copied every morning on to a special blackboard, with appropriate headings painted on to it, in the geography room which fortunately happens to overlook that part of the gardens where the screens are located. The board is *almost* always kept up to date for the simple reason that whoever fills it up has automatic permission to miss morning assembly, and apparently this is a considerable incentive. This blackboard is surprisingly useful in the course of ordinary geography lessons and reference may frequently be made to it at almost any stage in the syllabus. In the first place, it obviously helps to provide a standard of comparison. We may not always realize that the climatic statistics so often quoted in textbooks can be quite meaningless to young children unless they can compare them with some standard of their own experience. It also helps them to appreciate what such terms as "hot", "cold", "cool" and "mild" really mean in terms of degrees Fahrenheit. In fact, with a little practice, they become quite good at guessing outside temperatures to within a few degrees. They begin to appreciate what is meant by large and small diurnal ranges of temperature or what half an inch of rain really amounts to in terms of a waterlogged cricket pitch, and then they can begin to *feel* what it must be like in Bergen, or Bombay, or, of course, the inevitable Cherrapunji.

With nearly three years of detailed records behind us, we already have some statistics of our own. (Actually, with the kind co-operation of the Lee River Conservancy Board, we have at our disposal over a hundred years of rainfall records in our area.) But even three years can provide some quite interesting material. There is almost no end to

Fig. 1.—Mean monthly maximum and minimum temperatures in °F, Kew (solid line) and Cheshunt (dashed line).

the variety of graphs and diagrams which can be plotted from these statistics but it may be of some interest to illustrate three only. Figure 1 shows our own mean monthly maximum and minimum temperatures plotted against the official statistics from Kew. Apart from the obvious seasonal swing of temperature from the summer sixties to the winter forties, the graph clearly shows the greater diurnal range of temperature in summer, with its greater insolation by day and greater radiation at night, especially during the fine summer of 1959. Of course, this will show up even better if the daily *extremes* are plotted, for, say, January and July. But the graph reveals a more interesting phenomenon in the consistently greater range of temperature for Cheshunt as compared with Kew. It is particularly noticeable that the mean minima average two and a half to three degrees lower. We did not realize it when we were plotting this, but the difference presumably reflects the "heat-island" over the urban area of London at night and which normally begins to build up a little way to the south of us. The difference in altitude between the two stations is negligible and the difference cannot be due to instrumental error, since, in the period concerned, two N.P.L. tested minimum thermometers were used and both show the same trend. The difference between the mean maxima is small. In summer, Cheshunt seems to get about a degree warmer than Kew, but in winter there seems to be virtually no difference. However, from the teacher's point of view, it is not so much the theoretical explanations of the phenomenon which are important as the fact that here the pupils have discovered something of interest by plotting statistics which are based on *their own* temperature observations and records. Once they see this, it obviously makes the twice-daily routine much more meaningful and they begin to appreciate the need for care and accuracy.

Figure 2 shows an ordinary type of wind rose. At the top, the winds for a year, based on twice-daily observations, are shown, each space representing one observation, with eighty-nine recorded calms (i.e.

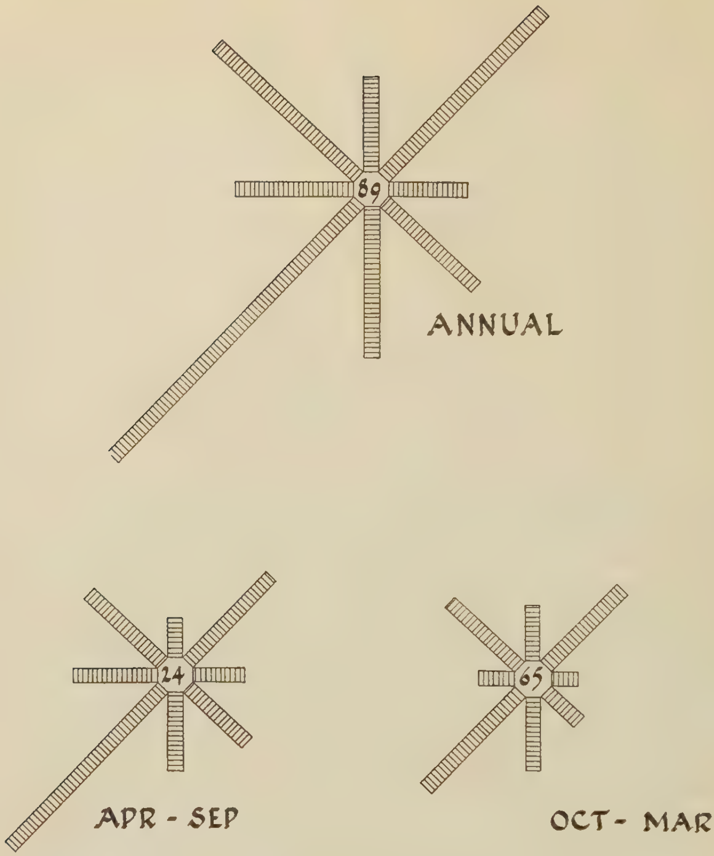

Fig. 2.—Wind roses for Cheshunt, April, 1959 to March, 1960.

Beaufort Scale 1 or 0). But, when we divide the year into the summer and winter seasons, we see, first, that in winter there were rather fewer southwesterlies and rather more northerlies than in summer. Even more significant, we had nearly three times as many calms in the winter half of the year. It would, of course, be interesting to compare these features with those which would be found in a similar wind rose from a station on the west coast of Britain. From our point of view, a significant point emerges when the high number of winter calms is set against the greatly increased relative humidity at this season (which can be shown by plotting the monthly means on an ordinary bar graph). This goes a long way towards explaining the notorious incidence of winter fog in the Lea Valley; and added point may be given to this by the fact that the screens need washing out (not a very popular chore!) far more frequently during the winter months.

Figure 3 shows a comparative rainfall graph which would not have been possible at all without the statistics made available to us by the Survey. Boys are always glad to spot a rival, with whom they can compete in almost any imaginable field, and climatology is no

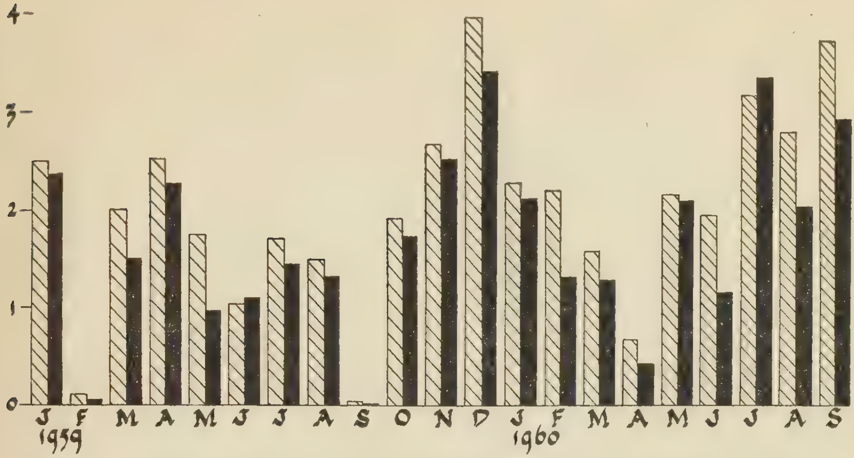

Fig. 3.—Monthly rainfall in inches, Southgate (hatched) and Cheshunt (black).

exception. Although they have been blissfully unaware of it, a school in Southgate has been our climatological rival for some time. (This may have arisen originally when a popular member of our teaching staff moved to a post at the other school.) Anyway, what could be more natural than to plot the rainfall records of the two schools (as supplied by the Survey) side by side? And we find, to our great satisfaction, that, with only two exceptions since the Survey started, their rainfall has been consistently greater than ours, the two exceptions being in June, 1959 and July, 1960, when our log recorded heavy thunderstorms in the Lea Valley which presumably upset the norm. This graph is, of course, taken as conclusive proof of the superior climate of Cheshunt over that of Southgate which is at least nine miles away to the southwest and therefore "nearer to the moisture-bearing prevailing winds". Perhaps it need hardly be said that what the graph really demonstrates is a contrast in the siting of the two stations—a contrast between a relatively exposed position at something over 200 feet and the sheltered flood-plain of the River Lea.

These three simple examples may be sufficient to illustrate the kind of elementary practical work which can be done with one's own statistics and those of other stations and which may, quite often, yield interesting and unsuspected results. More ambitious and more profitable projects will doubtless occur to many teachers. Thus, some schools participating in the Survey have produced isothermal and isohyetal maps of the North London area, based on the statistics supplied, while others have been able to plot the tracks of thunderstorms by noting the distribution of exceptionally heavy rain. One's own experience is that there is a limit to what can be done in this way, due mainly to the fact that the stations are still not closely enough spaced over a wide enough area, and also because it is difficult to make allowances for anomalies due to

differences in altitude, aspect, exposure and so on. Further, it must be admitted that there are many gaps in the records of some stations, though these are not always the fault of the school concerned. One station at Hatfield is out of action at the moment due to a "freak, hurricane-force gust of wind which overturned the screen and left us with a small amount of broken glass"! An even more pathetic story comes from another school which reported: "Some louts entered the premises a few week-ends ago and left the anemometer and Stevenson screen as a tangled mass of debris." Some sites are bound to be more vulnerable to this kind of thing than others, since, of necessity, the screen must be placed at a distance from buildings. The main difficulty of becoming operative again is that, even where the money for replacement is immediately forthcoming, the National Physical Laboratory now seems to be taking anything up to six months to certify an ordinary thermometer. It would be interesting to know whether there is any means of speeding things up a bit in this connection.

Perhaps the foregoing remarks may suggest, albeit briefly and inadequately, that it is worth while running a school weather station and that if it is done conscientiously and consistently one is bound to be repaid in a greatly increased consciousness of the influence of the weather and a greater understanding of the factors which control it, not only from the sixth form but throughout the school. Furthermore, that it is most useful to belong to an organization for exchanging statistics and other information. There are, of course, other excellent schemes to this end than the one considered here, but my purpose has been to add a short postscript to Mr. Chandler's paper on the effect which his particular project is having on those schools and colleges which are taking part in it. On their behalf, I should like to take this opportunity to express our appreciation of the hard work and efficient organization which has gone into the running of what we must now call the London Climatological Survey. It is evident that Mr. Chandler's concern has been as much for the benefit of the participating schools as for his own research and it is to be hoped that the increased administrative and financial problems, which must be inherent in the widening of the scheme, will be solved.

The Production and Refining of Indigenous Oil in Britain

B. S. HOYLE

A close relationship between the East Midlands of England and the southeastern part of the Midland Valley of Scotland is a recurring theme in the history of the British oil industry. At the present time the link between Nottinghamshire and the Lothian counties remains the prime feature of the geography of the industry, since the entire British home production of crude oil, almost all of which comes from the East Midlands, is treated together with the production of the Scottish oil-shale mines in West and Mid-Lothian at the small refinery at Pumpherston (Midlothian) operated by the British Petroleum Company. The output of this plant represents, of course, only a very small part (less than half of 1 per cent) of the total consumption of petroleum products in Britain, but the refinery itself is of considerable interest since in many ways it is unique.

Small oil "shows" have been noted and utilized in Britain since Roman times, but the first active exploitation of indigenous crude oil resources resulted from the chance discovery of oil at Alfreton (Derbyshire) by James Oakes in 1847. In the same year James Young, a well-known Glasgow chemist then working in Manchester, set up a small distillation plant to treat this oil, but the supply was soon exhausted. As a further development, Young transferred his activities to Scotland, where in 1850 he began processing the Boghead coal, a very rich cannel coal, at Bathgate (Midlothian), using iron retorts. When this became uneconomic, he turned in 1859 to the distillation of the oil shales found in the Calciferous Sandstone Series at the base of the Carboniferous system in the Broxburn and West Calder districts. The actual processes involved in the distillation of oil from shale had been known since the seventeenth century, but Young developed an economic means of utilizing them. The yield from the shales was very much lower than from the Boghead coal, but their relative abundance and cheapness of mining made them an economic proposition, and provided the basis for the oil-shale industry which has survived to this day. It is recorded that in 1865, the year after Young's patent expired, there were in Scotland 120 works retorting oil shales and cannel coals; many were very small plants, operated as adjuncts to collieries which happened to have suitable cannel coals available. In

➤ Mr. Hoyle is Assistant Lecturer in Geography at Makerere University College, Kampala, Uganda. He is indebted to the British Petroleum Company, the Petroleum Information Bureau and Scottish Oils Ltd. for their generous provision of statistical material, and to A. Serubiri for cartographical assistance. Acknowledgement is made also to the Department of Geography, Makerere University College, for financial aid towards costs of publication.

addition to the distillation plants at Bathgate (1851), Broxburn (1858), and Addiewell (1865), a fourth plant was built at Pumpherston in 1883. Like the early Alfreton works, all these plants were located in immediate proximity to the source of raw materials; their chief product was initially burning oil, but as the value of this declined greater attention was paid to lubricating oils and paraffin wax. Many of these works were abandoned in the later nineteenth century, when, from about 1860, the competition of American finished products, particularly kerosene, was keenly felt, and only twelve were in operation in 1900. The output of shale reached a maximum of 3·28 million tons in 1913, when further expansion was checked by the first World War. In the subsequent period the scale of operations has been progressively reduced, and the annual output of shale now stands at about 750,000 tons, from which about 60,000 tons of oil are obtained. Only three shale mines remain in operation, and the shale is now retorted in one crude oil works, at Westwood (see Fig. 1 and Plate II). About 1900 people are employed in the industry, of whom 700 work in the shale mines and a further 1200 in the crude oil works, refinery and allied activities.

The Lothian oil-shale field is composed of a series of anticlines and synclines in which a large number of faults occur; as a result, the area served by each mine opening is never of very great extent, varying from 150 to 500 acres. Two seams important in the early days—the Fells, which was 3½ feet thick and gave a yield of 40 gallons of oil per ton of shale mined, and the Broxburn, 4½ feet thick and yielding 25 gallons of oil per ton of shale mined—are both now exhausted. Some of the seams worked at the present time are considerably thicker, but have lower yields. Originally, opencast and adit mining were the methods used to extract the shale; later more economical inclined mines were developed where the shale outcrops at the surface, with vertical shafts elsewhere.[1]

Commercial production of crude oil in Britain began in 1939 with the almost simultaneous discovery of oil fields at Formby (Lancashire) and Eakring (Nottinghamshire).[2] The discoveries were made by geophysical methods, especially the seismic (refraction) system, and in both cases the oil proved to be of excellent quality. Wartime requirements and the need to conserve tanker tonnage encouraged the rapid development of these fields, but production has never exceeded the maximum figure of 112,000 tons reached in 1943 (see Fig. 3). Post-war exploration has extended the area of the East Midlands field considerably; Egmanton and Duke's Wood have replaced Eakring as the chief centres of production, but the output of the wells at Kelham Hills is now rapidly declining. South of the Trent oil has been found at Plungar and Langar in the Vale of Belvoir, and proved for a time to be of commercial significance, although production at Langar has now ceased. However, the total production from the wells in the East Midlands fields remains less than the output from the Eakring field

Fig. 1.—The oil industry of the Lothians, 1961.

alone in the peak years 1943–44. Since 1948 water-flooding has been used as a method of secondary recovery, and it is estimated that the cumulative production has been about one and three-quarter times what it would have been under conditions of natural depletion; the process of water-flooding involves the injection of oxygen-free water by means of high-pressure pumps into wells which are either specially drilled for the purpose or are normal production wells which no longer yield oil; the injection rate may vary from 300 to 30,000 gallons of water a day, and the purpose of injecting water into oil-bearing strata is to raise the oil-level and thereby to increase pressure and production; the method is only economical in relatively shallow fields where drilling costs are low.

The production of the wells at Formby is still very small, but it is thought that the main oil reservoir there may not yet have been tapped. Exploratory drillings have been and are being carried out in various other parts of the country, and although only one important discovery has been made recently—at Kimmeridge, Dorset, in 1959—valuable geological information has been gleaned. Sources of natural gas—Grosmont, Yorkshire, and Cousland, Midlothian—and potash deposits

—Eskdale, Yorkshire—have been located. Figure 2 shows the centres of oil production in the East Midlands, and the output of all British oilfields and of the Scottish shale oil field in recent years is given in Table 1.

Situated some eleven miles west of Edinburgh, in the heart of the Lothian shale field, Pumpherston Refinery is operated by a company known as Scottish Oils Ltd. During World War 1 a scheme was introduced for the joint marketing of certain oil products by the six remaining oil companies in Scotland; in 1919 this scheme was extended to cover all products, and the six companies were at the same time brought under one management and re-organized as Scottish Oils Ltd., whose ordinary capital was subscribed by the Anglo-Iranian Oil Company Ltd. Scottish Oils Ltd. now forms a subsidiary member of the B.P. group of companies. The Pumpherston plant originated in 1883 as one of several built to retort and distil shale following Young's developments. Later, when shale mining in the immediate vicinity

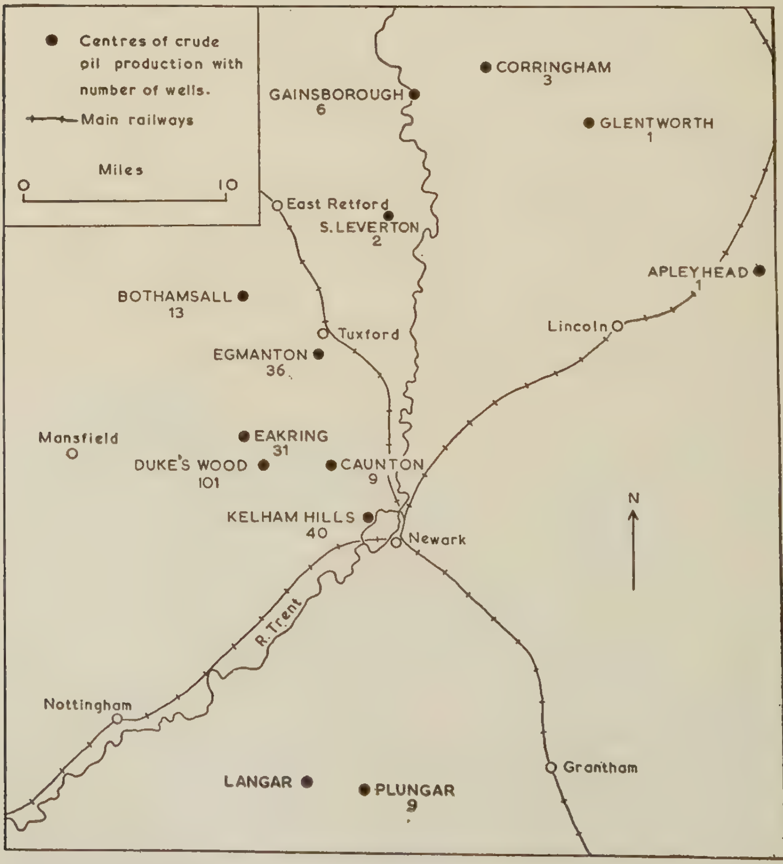

Fig. 2.—The East Midlands oilfields, 1961. Of the 262 oil wells currently in production in Britain, 252 are in the East Midlands; the remainder are at Formby (9) and Kimmeridge (1).

Table I. Oil Production in Britain (by Fields), 1955–60
(Figures given in Imperial Tons)

Fields	*Date*[a]	1955	1956	1957	1958	1959	1960
Scottish shale oil field	1851	96,712	77,628	71,130	63,362	60,508	60,000
East Midlands							
Eakring	1939	7,822	7,310	6,218	6,755	4,844	3,085
Duke's Wood	1941	24,464	29,562	29,184	21,164	18,165	16,830
Kelham Hills	1941	16,237	13,521	14,816	9,484	8,032	7,646
Caunton	1943	1,385	1,542	1,319	1,146	1,066	870
Plungar	1954	2,158	4,891	3,268	3,329	3,525	3,425
Egmanton	1955	896	9,049	26,988	37,270	33,783	26,571
Bothamsall	1958	—	—	—	646	7,439	18,651
Langar	1958	—	—	—	68	12	—
Corringham	1959	—	—	—	385	2,109	3,496
Gainsborough	1959	—	—	—	—	1,211	3,958
Apleyhead	1960	—	—	—	—	—	85
South Leverton	1960	—	—	—	—	—	549
	Total:	52,962	65,875	81,793	80,247	80,186	85,166
Other sources of crude oil							
Dalkeith[b]	1938	93	138	91	90	—	—
Formby	1939	161	120	131	114	81	71
Kimmeridge	1959	—	—	—	—	2,336	44
	Total:	254	258	222	204	2,417	115
	General total:	149,928	143,761	153,145	143,813	143,111	145,281

(a) The date of commencement of commercial exploitation.
(b) The Dalkeith wells are operated by the Esso Petroleum Company; all other fields are operated by the B.P. Exploration Company (formerly the D'Arcy Exploration Company).
Sources: Petroleum Information Bureau; Scottish Oils Ltd.; British Petroleum Company.

Table II. Activity of Pumpherston Refinery, 1952–60
(Figures given in Imperial Tons)

Year	*Tonnage of Scottish shale oil refined*	*Tonnage of English crude oil refined*	*Total*[a]
1952	105,773	53,249	159,060
1953	103,636	55,137	158,903
1954	100,262	59,188	159,590
1955	96,678	52,463	149,234
1956	78,468	64,436	143,042
1957	71,128	79,439	150,658
1958	63,143	79,829	143,062
1959	60,328	79,698	140,116
1960	59,925	84,621	144,546

(a) The total figures include the crude oil production of the Esso Petroleum Company's well at Dalkeith (Midlothian). Source: Scottish Oils Ltd.

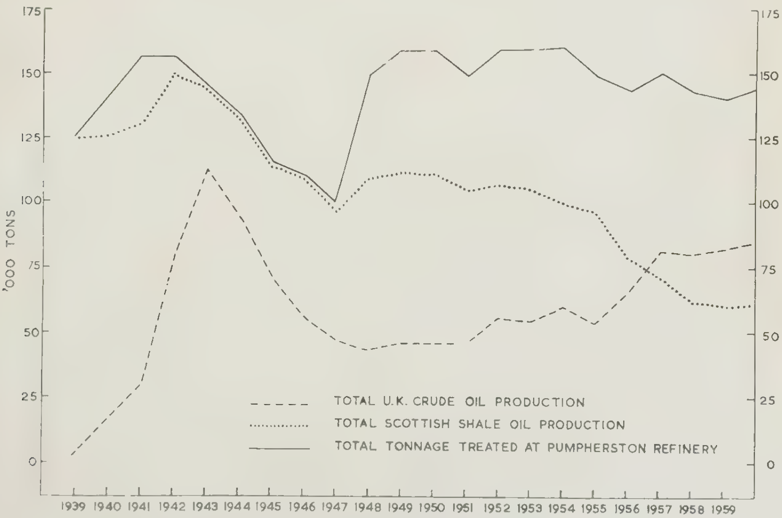

Fig. 3.—Oil production in Britain.

Plates I and II.—A contrast in British oilfield landscapes. Above, an oil well at Duke's Wood in the Eakring district, Nottinghamshire. Below, Westwood crude oil works, West Lothian, taken from the top of one of the spent shale bings which are outstanding features of the Scottish shale-oil field.

(*Photographs by kind permission of British Petroleum Co Ltd.*)

ceased and retorting was discontinued, the Pumpherston works continued as a refinery, which from 1936 has been the only plant treating the output of the Scottish shale oil mines. English crude oil was refined at Ellesmere Port during the wartime period, but has been treated exclusively at Pumpherston since 1946. Pumpherston has thus been developed as the central refinery for both the Scottish shale oil and the English crude oil production, and is therefore unique among British refineries since it treats entirely home-produced oil and is situated in the source area of some at least of its raw materials. A comparison may perhaps be suggested with the small refinery at Merckwiller, Alsace, which treats quantities of Alsatian oil comparable to those refined at Pumpherston.

Pumpherston is now one of seven small refineries in Britain with capacities of less than 250,000 tons per annum, as opposed to the major refineries with capacities ranging from 1·9 to 10·5 million tons per annum. All the smaller refineries—the others are located at Ellesmere Port, Manchester, Ardrossan, Weaste (Salford, Lancs.), Kingsnorth (on the lower Medway opposite Gillingham, not far from the Isle of Grain refinery) and Dundee—deal with special crude oils rather than with large quantities of Middle Eastern oil. None has been significantly expanded in post-war years, in contrast to the larger refineries, and only Pumpherston and Ellesmere Port have cracking plants (thermal, not catalytic) and these are not of the most modern design. As a group, the smaller refineries lie further inland than the major plants (especially Pumpherston and the two near Manchester), and thus are to some extent disadvantageously situated in relation to the supply of raw materials both from oil-importing ports and from British oil fields. In this latter respect, Pumpherston is an extreme case, since a 270-mile rail journey is involved.

The refining of British home-produced oil has been concentrated at Pumpherston because the refinery was for several reasons the most convenient plant for the purpose belonging to the B.P. Company. Other B.P. refineries located at Grangemouth, Llandarcy and Isle of Grain, all at a considerable distance from the East Midlands fields, are designed to handle large quantities of crude oil from the Middle East, and it would be difficult to treat separately there the indigenous crude oil and its principal products—petrol and diesel oil—on which there has been since 1950 a preferential Excise duty, only 50 per cent of the rate payable on imported crude oil. (Before 1950 no duty was payable on the products of indigenous oil.) Further, at the time when commercial production in the East Midlands began, the Scottish shale output was declining and Pumpherston refinery, which has a capacity of 180,000 tons per annum, had a considerable capacity margin. It was therefore plainly convenient to utilize this margin for the treatment of crude oil from England and thus concentrate the refining of all indigenous oil in a single, separate unit.

The method of refining crude oil from the East Midlands is, conveniently, substantially the same as that for shale oil. Shale oil differs from crude oil in that it contains a greater proportion of unsaturated hydrocarbons, nitrogen bases and phenolic bodies, so that the lighter products of shale oil require refining by sulphuric acid and caustic soda, while the comparative fractions (cuts) from East Midlands oils do not.[3] Otherwise the processes of refining these two oils are practically the same and consist of :

(1) primary distillation, the two types of crude oil being treated separately,
(2) extraction of wax from the wax-bearing fractions,
(3) mild cracking of the residue,
(4) refining of diesel oil,
(5) refining of motor spirit,
(6) refining of paraffin wax.

The products obtained from shale oil and English crude oil at Pumpherston are therefore mainly diesel oil and petrol, which, as mentioned earlier, benefit from a preferential rate of duty on home-produced oil; the diesel oil is of high quality, but the petrol has a low octane value and is blended with other B.P. petrols before sale. Solvent naphthas and paraffin wax are other important products. By-products from shale oil include a range of synthetic detergent compounds manufactured at Pumpherston, based on naturally occurring olefins in the Scottish shale oil; also, after several years of experimental work, it has been found possible to produce building bricks in considerable quantities from the spent shale. At present spent shale is being used as ballast in land road construction connected with the new Forth Road Bridge.

A comparison of the two parts of the British oil-producing industry reveals that they are in contrasting stages of development. The Scottish shale oil industry is clearly in decline, and has been so for some time, whereas the production of crude oil in England has recently shown a renewed upward trend, although the 1943 maximum has not yet again been reached. The decline of the Scottish industry has taken place in spite of the fact that there remain considerable quantities of shale that could be worked, especially in the southern part of West Lothian. The growth and development of many towns and villages in West Lothian have been profoundly influenced by the oil shale industry, and they have been largely dependent upon it as a source of employment; Uphall, Broxburn, Winchburgh, Pumpherston and Seafield are examples. The slow process of closing down the mines and oil works, largely a result of competition from imported oil, has caused considerable anxiety since alternative forms of employment are not readily available for the displaced workers. The number of unemployed persons in West Lothian almost doubled in the twelve-month period 1958–59, and the percentage of unemployed persons in the south of

the county is well above the national average.[4] This feature is largely to be attributed to over-dependence upon the declining coal- and shale-mining industries, and local authorities are attempting to bring about a greater diversification of the economy by attracting new industries to the area; a case in point is the introduction of a new B.M.C. factory at Bathgate.

The production of crude oil in England, on the other hand, does not require a large labour force, and has not had a very marked effect upon the economy of the East Midlands; in fact, it will probably appear in the future as a transitory phase of no very great long-term significance. The value of the crude-oil production of Nottinghamshire and adjacent counties does not lie wholly in the almost insignificant contribution which it makes to the country's needs; the oil field has a particular value and importance as a training ground for geologists, petroleum engineers, drilling teams and others who later work in major oil fields abroad, and as a testing ground for new methods and techniques. In a similar way the Scottish shale-oil industry, struggling in the later nineteenth century to make a profit in the face of increasingly severe foreign competition, developed new and more economical methods of refining, and contributed many notable advances to the technology of petroleum; but its survival was closely related to the geographical position of the shale field, without which the technical advances and resultant economies would have been of little avail—the proximity of a market area in Scotland's industrial districts, of coalfields with adequate coal and labour supplies, and of port facilities for dealing with exports, were all factors of vital importance. The significance of both parts of the British home oil industry has thus, at different times and in different ways, outweighed their small contribution to the nation's consumption of petroleum products.

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Research in Picture Study

The Reaction of Grammar School Pupils to Geographical Pictures

THE PURPOSE OF THIS INVESTIGATION was to obtain some facts about the ability of secondary school children to recognize features shown in geographical photographs. It developed as the continuation of a previous investigation by the Research Committee of the Training Colleges Section of the Geographical Association, designed to obtain some facts about the ability of children to understand what is shown in photographs of physical geography and reported in *Geography*, vol. xxxviii, 1953, pp. 100–7. Photographs used in the earlier experiment omitted as far as possible all signs of human activity; for the purpose of the second investigation the two photographs finally selected by the Committee were considered to be normal geographical pictures showing marked physical features with some indication of human response. Although the results analysed in this report refer only to grammar school pupils, it must be emphasized that the experiment was devised for both secondary grammar and secondary modern school children.

It was considered that the soundest way of providing a truly representative cross-section of secondary school children was to present the necessary questionnaires in a number of schools, since any research limited to one school might be unduly weighted by personality, method, interpretation or presentation. The investigation was therefore conducted in a large number of secondary schools of all types in various parts of England and Wales, with the generous support and co-operation of the staffs. The first sets of completed questionnaires covering both pictures were received from ten single-sex grammar schools, serving both rural and urban areas, and taking "O" level syllabus, thus:

Schools	*Numbers tested*	*Year* 1 *Ages* 11–12	*Year* 2 *Ages* 12–13	*Year* 3 *Ages* 13–14	*Year* 4 *Ages* 14–15	*Year* 5 *Ages* 15–16
5	Girls	203	260	209	233	163
5	Boys	246	235	258	197	173

Since these represent only a sample of the population tested, although including a, b and c streams of the normal grammar school grading, it may well be that the conclusions drawn from their work should be

➤ This is an interim report on an investigation carried out by the Training Colleges Section of the Geographical Association during the period 1955–57, collated and presented by Mrs. M. Long, Lecturer in Geography at the University of London Institute of Education and Chairman of the Training Colleges Section Committee of the Association.

regarded as tentative. As the numbers tested for each of the five school years are unequal the results are given as percentages to facilitate comparisons.

The test was devised by the Committee to be completed within two school periods. These were normally two successive geography periods. In each period a large, clear print of a picture was given to each child to study, accompanied by a three-part paper. The first picture was a low air oblique entitled "Fishing Village, Polperro, Cornwall" (Plate I), the second was a ground-level landscape entitled "Fishing Village, Shieldaig, Ross-shire" (Plate II). The pictures were chosen by the Committee as being broadly similar, in that they both showed a simple settlement pattern in a maritime environment. Any difference of response by the children to comparable pictures could thus be considered.

The children first completed brief details of their name, age, class and school on the double-page foolscap answer sheet; then, entirely unaided, answered first Section I, which was: "Write as much as you can about the picture." This particular phrase was selected as offering the minimum directive to children. It was realized that descriptive or interpretative rendering could be given according to the child's age, learning experience and knowledge of the part of the country depicted. It was considered that answers might indicate changing interpretation with age, which in itself would be instructive. An almost complete page was available for this writing; at the end of twenty minutes the children were told to turn over and complete Sections II and III.

On the inner pages of the answer sheet, not previously inspected by the children, Sections II and III faced a large line drawing of the photograph (Figs. 1 and 2), to indicate precisely the areas in the picture to which the questions of Section II referred, and on which were to be written the answers to Section III. Below each question printed in Section II were a few lines left for the answers; for both the Polperro and Shieldaig pictures all the questions were devised to be similar within the limits of the photographs. Since they were intended for answer by all types of secondary school children within a wide age range, they were simple questions, designed to test powers of observation and recognition, and were not in any way a graded test of ability. They were as follows:

Section II. Polperro

1. Is the tide at its highest? Give reasons for your answer.
2. What is the land like at A?
3. What is the land like at B?
4. What is the land like at C?
5. The land at D is used for growing crops. Why is this a good place to grow them?
6. What is the land like at E?
7. Write a sentence or two describing the position of the houses.

Section II. Shieldaig

1. Is the tide at its highest? Give reasons for your answer.
2. What is the land like at A?
3. What is the land like at B?
4. What is the land like at C?
5. What is the land like at D?
6. What is the land like at E?
7. The land between (F) and (G) is used for growing crops. Why is this a good place to grow them?

Section III was a short section, requiring different skills. For both Polperro and Shieldaig the children were asked:

With the help of the picture:

(a) Shade in pencil, on the drawing opposite, the areas of land which are flat or nearly flat.

(b) Put an S in the margin of the drawing opposite, on the side from which the sun is shining.

For the Polperro picture were two additional requests:

(c) Draw this, vvvv, on the drawing opposite, wherever you can see foam on the water. Suggest reasons why it is there and not in other places.

(d) Find a valley, a cliff, a harbour. Write each of these words once on the drawing in the right place.

The following scripts have been selected as being typical of the written work called for in Section I.

Boy, aged 11 years 10 months, describing Polperro: "There is a lighthouse. There are a lot of houses in the main part of the village. There are many fields and hills. There are many fishing boats and pleasure boats. The village is situated on a river which flows from the valleys to the sea. There are some telegraph poles. The village is surrounded by a forest. There are many roads one leeds to the lighthouse."

Girl, aged 15 years 9 months, describing Polperro: "Polperro is a small fishing village on the south coast of England. The coast-line is rocky and indented. There is good pasture land a little way inland, and the vallies are wooded. Small farms are many. There is a natural harbour and fishing is the main occupation. There is not much sand on beaches (for the tourists), it's only attraction being the scenic beauty. There is good arable land and very little of it is wasted. Because of the rocky coastline, the sea is always rough. The houses reach down to the sea, and the time is probably mid-day, when the fishing boats are moored up the beach and on the quay. The land above the cliffs is covered with small bushes."

Girl, aged 12 years, describing Shieldaig: "From the picture it does not look as if the place is to do with fishing because I cannot see any fishing boats, or nets, or anything to do with this work. On the hillside there are animals grazing, perhaps sheep or cows. This area of land is good for grazing because the mild air from the coast line is good for this. Their is no foam on the water because there are no large rocks for the tides to lash up against. The tide looks very calm, and looks as if it is usually like this because there are only small rocks, and if the tide was rough there would be large rocks. The small residences round the coast may be for some people who get their fish supply from the sea round the coast, they could not be there to send the fish supply off to other parts because it is not a main fishing village."

Boy, aged 15 years 9 months, describing Shieldaig: "This is a small fishing village in Scotland. Nearly all the livelihood of the place depends on the fish that are caught. The land is very barren and poor with very few crops being grown. There are very few communications. There appears to be no railway and therefore the only communication would be by road. The village is very small and there is only one main road running through the town. The villagers would be hard working and have little leisure time. There are no amusements to be seen and the people would have to amuse themselves in their own homes. The village is surrounded by high hills or mountains, and, on one side, by the sea. The houses are small and strong and covered by trees and small hills from inland winds. The shore is composed of rocks and boulders. The ground is very infertile. It is mostly hard bare rock covered by a few inches of very thin sparse grass. There are very few trees and those found have probably been purposely planted. The natural vegetation would be thin sparse grass just covering the rock. There are only a few houses from the seashore. These probably belong to poor farmers. These farmers would mainly keep animals and not cultivate the ground for crops."

The influence of teaching is apparent, children reading into the pictures what they have been taught.

A list of features or objects recorded by the children was drawn up from a large number of scripts examined by members of the Committee, to which were added other items clearly visible in the photographs. The omission of a few minor objects such as an obelisk of uncertain purpose in the extreme bottom right-hand corner of the Polperro picture reduced the lists to twenty items for each picture. Assessment was undertaken by eight training college lecturers, who first analysed each script to see which features or objects had been recorded.

Table I shows the features of the Polperro picture, arranged in order of maximum mention by girls. The percentages for the boys are on the right-hand side of each column. It will be seen that the list includes both human and physical or natural features, and that one general term, i.e. scenery, is included, should the children make any general reference to the area shown. Reference to the sun is also included, but mention of shadows or sky was permitted under this heading as the sun itself is not visible in this photograph. The chart indicates:

(i) that no item was recorded by every boy or girl;

(ii) that despite the lead given by the title to the picture, some 20 per cent of the children make no reference to the village as such;

(iii) that although the items recorded by the majority of the children vary slightly according to age or sex, the most commonly recorded features are the same for each of the five years. Of the human features, these are the village, its houses, the harbour, the roads, fields, trees and boats; of the physical features, the hills, rocks and the sea;

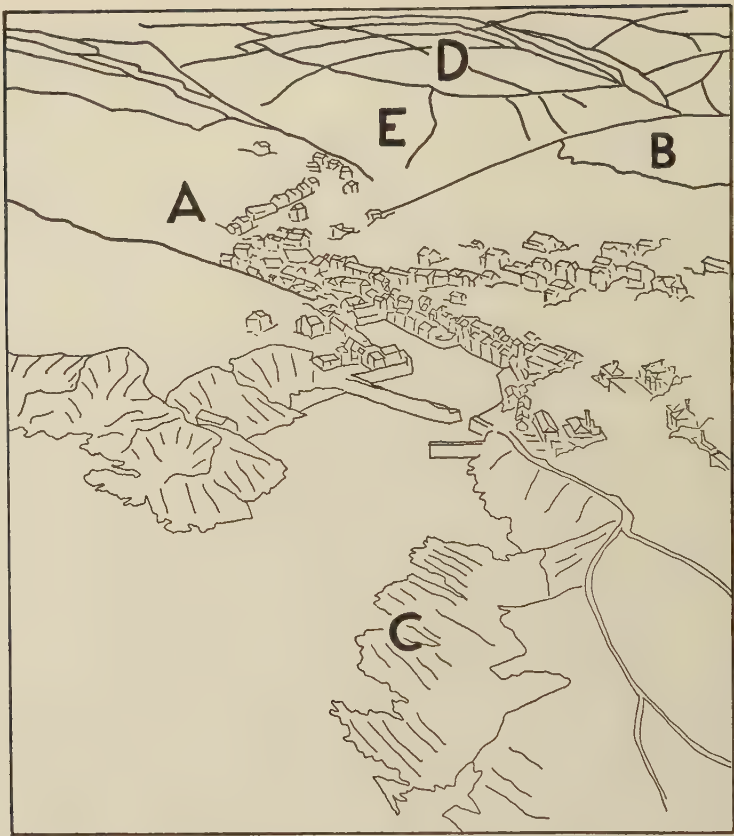

Fig. 1.—Line drawing for Sections II and III of the test on Polperro. The actual drawing was about the same size as the photograph, and approximately 4 times the area of this reproduction.

Table I

Polperro, Section I. Items Recorded by Children in Undirected Search

	Year I	% G	% B	*Year II*	% G	% B	*Year III*	% G	% B	*Year IV*	% G	% B	*Year V*	% G	% B
1	Rocks	80	70	Houses	95	72	Trees	90	74	Trees	88	77	Village	86	80
2	Village	79	75	Trees	86	62	Houses	85	74	Houses	85	75	Trees	79	70
3	Hills	74	68	Harbour	80	74	Village	84	80	Village	84	85	Harbour	78	78
4	Houses	74	73	Village	80	79	Boats	77	65	Rocks	80	72	Houses	78	76
5	Trees	74	56	Hills	77	59	Roads	76	70	Harbour	77	74	Boats	71	59
6	Boats	69	77	Rocks	72	70	Rocks	74	68	Hills	75	73	Rocks	68	64
7	Sea	64	41	Sea	72	57	Sea	72	49	Boats	68	60	Hills	63	49
8	Harbour	63	56	Roads	71	65	Harbour	70	78	Sea	67	58	Sea	62	49
9	Roads	57	56	Boats	64	77	Hills	70	67	Roads	66	71	Roads	54	47
10	Fields	40	54	Fields	54	57	Fields	63	49	Fields	60	54	Cliffs	52	48
11	Valley	38	33	Cliffs	44	40	Cliffs	41	48	Shore	51	42	Shore	47	37
12	Cliffs	36	33	Valley	42	40	Shore	41	34	Jetty	41	46	Fields	43	29
13	Shore	30	11	Jetty	29	36	Valley	32	48	Cliffs	40	41	Valley	43	52
14	Crops	28	14	Estuary	27	33	Jetty	27	40	Valley	38	56	Crops	39	38
15	Jetty	25	30	Crops	26	30	Estuary	27	43	Estuary	29	47	Estuary	39	36
16	Estuary	24	18	River	24	21	River	23	22	Crops	24	35	River	32	16
17	Scenery	14	3	Shore	23	17	Crops	22	32	Foam	17	10	Jetty	27	32
18	River	12	22	Scenery	11	4	Foam	16	13	River	15	18	Scenery	19	14
19	Foam	12	6	Foam	7	15	Scenery	15	10	Sun	15	12	Foam	9	12
20	Sun	7	10	Sun	7	12	Sun	9	13	Scenery	11	8	Sun	8	20

(*Photograph by Aerofilms and Aero Pictorial Ltd.*)

Plate I.—The photograph of Polperro used in the tests.

(*Photograph by C. Righton Campin*)

Plate II.—The photograph of Shieldaig used in the tests.

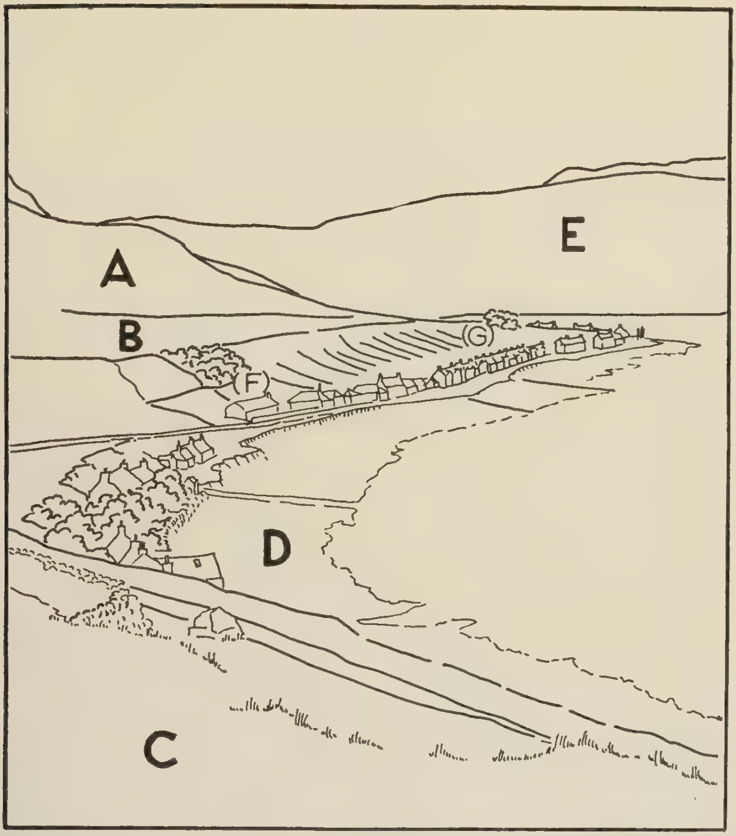

Fig. 2.—Line drawing for Sections II and III of the test on Shieldaig. The actual drawing was about the same size as the photograph and approximately 4 times the area of this reproduction.

Table II

Shieldaig, Section I. Items Recorded by Children in Undirected Search

	Year I	% G	% B	*Year II*	% G	% B	*Year III*	% G	% B	*Year IV*	% G	% B	*Year V*	% G	% B
1	Hills	96	98	Hills	95	72	Hills	91	93	Hills	88	81	Village	75	83
2	Houses	91	87	Houses	92	68	Houses	88	86	Houses	86	87	Houses	68	66
3	Stones	89	81	Beach	80	73	Beach	86	81	Stones	86	77	Hills	66	72
4	Beach	75	82	Stones	76	68	Stones	82	80	Beach	79	76	Boats	62	67
5	Sea	72	76	Grass	70	52	Trees	73	76	Sea	73	76	Sea	62	60
6	Trees	63	66	Trees	67	44	Sea	66	76	Trees	66	68	Beach	57	61
7	Grass	61	36	Sea	60	67	Grass	60	68	Grass	60	57	Trees	51	51
8	Roads	46	51	Village	58	56	Fields	54	53	Village	51	65	Roads	48	39
9	Village	40	73	Roads	54	34	Roads	52	64	Fields	49	27	Animals	41	47
10	Fields	38	39	Fields	49	41	Village	50	59	Sun	44	36	Grass	40	46
11	Sun	38	38	Wall	46	21	Wall	38	47	Roads	36	48	Stones	31	47
12	Wall	36	35	Sun	43	29	Sun	31	56	Wall	36	54	River	26	21
13	Bay	27	12	Bay	32	21	Bay	29	41	Boats	29	28	Sun	24	24
14	Animals	19	23	Boats	32	29	Animals	24	44	Bay	23	33	Raised beach	22	18
15	Boats	18	24	Animals	29	16	Boats	23	41	Animals	15	26	Bay	19	17
16	Valley	10	13	River	9	14	Cliff	9	15	Raised beach	10	1	Wall	17	18
17	River	9	14	Cliff	8	3	Valley	8	7	Scenery	9	11	Scenery	16	8
18	Raised beach	6	6	Valley	7	4	River	6	17	Valley	7	7	Cliff	6	5
19	Cliff	3	1	Raised beach	4	2	Scenery	6	1	River	6	18	Fields	6	9
20	Scenery	1	13	Scenery	4	4	Raised beach	4	2	Cliff	3	6	Valley	3	5

(iv) that although the items recorded by the minority of the children vary slightly according to age or sex, the least commonly recorded features are the same for each of the five years. Of the human features, these are the jetty and crops; of the physical or natural features, the valley, cliffs, shore, estuary, river, foam and sun;

(v) that less than 20 per cent of the children make some reference to the whole area by use of the term "scenery" or a comparable phrase.

Table II, for Shieldaig, lists twelve items which are substantially the same as those in the Polperro picture or closely comparable items. The outstandingly significant geographical feature of this picture is the raised beach. It is not to be expected that children are familiar with such a term so that although the actual phrase was used only by some 5 per cent of the children in the fifth year, and by ten boys in one fourth-year form, reference to the correct area of flat land was accepted under this heading. The chart indicates:

(i) that no one item was recorded by every boy or girl;

(ii) that despite the lead given by the title to the picture, an average of 40 per cent of the children make no reference to the village as such. This may be because they did not read the title, did not consider reference necessary as it was already printed, did not make use of the term, or did not recognize the pattern of settlement, i.e. a single row of houses, as the village;

(iii) that the commonly recorded features are similar to those in Table I, with some variation, for each of the five years. Of the human features these included the village, its houses, the trees and the grass; of the physical features, the sea and the beach with its stones and pebbles;

(iv) that, although the least commonly recorded items vary according to age or sex, they are the same for each of the five years. Of the human features these are roads, boats, walls, fields and animals; of the physical, the bay, the valley, river, cliff, raised beach and the sun;

(v) that, in general, less than 20 per cent of the children make some reference to the whole area by use of a general phrase or word such as "scenery".

It will be seen, therefore, that the human features noted by the majority and common to both pictures are the village, houses and trees, whilst physical features noted are the hills and the sea. The rocks of Polperro and the beach of Shieldaig are well recorded, as is the harbour of Polperro. Items common to both pictures but receiving relatively little comment are the valleys, cliffs, river and sun; the estuary of Polperro and the bay of Shieldaig are not well noted. It is significant that the human features, e.g. the roads, boats and fields, which are noted by a majority in the Polperro picture, but by a

minority only in the Shieldaig picture, have a far less obtrusive quality in the latter photograph and are fewer in number. It would appear that children mainly record, and therefore presumably observe, objects familiar to them, according to their position and conspicuousness in the picture. They appear to record less readily, and therefore presumably observe less readily, in these two pictures, physical features such as estuary, bay, valley or cliff; or it may be that they see these features, but may not be familiar with the geographical terms by which they might record them.

Further analysis of Section I reveals that the average number of items recorded by the children in each year varies slightly. The average of items for year 1 is eight for both pictures, boys and girls alike. For year 2 the average is nine; for year 3, ten, except for the boys who average eleven for the Shieldaig picture. But for years 4 and 5 the average is nine, although fifth-form girls record twelve items for the Polperro picture.

It would not therefore appear that ability to record items increases with age. The fewer items recorded by years 4 and 5, boys particularly, may indicate less interest in the search, or greater selective power applied to what they consider worth recording. Their written description included reference to facts known about the part of the country depicted, and to interpretative explanations; these aspects of the answers have yet to be analysed. First-year children appear to record fewer objects not entirely because they write more slowly, or search less carefully, but because they omit major items whilst including minor ones. Indeed, further verification of previous research findings that young children scrutinize pictures very carefully is given by phrases such as "The left end house has a skylight in the roof". "There is a good pull-in for cars just by the harbour." "Men are fishing from the harbour walls." "There is a van outside what I take to be the village shop", or even "In the right hand corner there is a label Aerofilms". There is further indication that the young child projects himself into the scene. "I wouldn't like to drive at more than 30 m.p.h. along that road, you'd end up in the sea." Or, written by a girl, "This is a very quiet and respectable village, not the sort I'd like for a holiday", or "I would certainly love living in such a delightful place. I would choose a house near the harbour with roses in the garden."

Evidence of lack of realization of scale at all ages is apparent. Some children estimate the height of the land to be from sixty feet to three hundred feet for the cliffs at Polperro; two hundred, three hundred, or four hundred feet to one thousand, two thousand or even four thousand feet for the Shieldaig highlands. The use of the word "mountains" to decribe the Polperro hills is common in the third year, and is to be found even in fourth-year papers. A wooded slope is seen as "a vast mass of trees", whilst the fields of Shieldaig are frequently called gardens presumably because of their proximity to the houses, which in their

turn are called huts. The raised beach is referred to by fifth formers as "a small patch of flat land" and "a vast plain".

Table III

Sample Mark Sheet for Polperro, Section II

Question	*Areas on Fig. 1*		M	G1 (32)	B1 (33)	G5 (32)	B5 (23)
1		Tide	1	20	23	20	21
		Reason	1	11	17	15	20
		Reason	1	0	6	5	11
2	A	Land form	1	6	4	23	16
		Adjective	1	2	22	2	13
		Vegetation	1	24	21	30	23
		Adjective	1	0	5	3	10
3	B	Land form	1	6	2	30	19
		Adjective	1	22	24	17	18
		Vegetation	1	6	12	19	19
		Adjective	1	1	0	1	5
4	C	Land form	1	32	32	31	23
		Adjective	1	6	6	21	21
		Vegetation	2	4	4	3	10
5	D	Level	1	14	16	24	15
		Relatively level	2	10	2	5	2
		Sunny	1	8	8	10	8
		Others	2	2	5	21	24
6	E	Land form	1	6	5	10	14
		Adjective	1	1	0	0	7
		Vegetation	1	20	26	32	23
		Adjective	1	2	3	18	12
7	H°	Valley	2	6	14	7	18
		Cove	1	4	0	9	0
		Head of cove	2	0	0	3	8
		On one side	1	0	4	4	3
		Water's edge	1	28	16	16	16
		Clustered	1	12	9	12	13
		Scattered	1	9	3	8	4
		Bottom of hill	1	1	1	2	4
		Sheltered	1	3	1	6	9

Assessment of the answers to Sections II and III was based on a standardized scheme devised by the Committee from preliminary surveys of completed questionnaires. Table III shows a sample mark sheet for Polperro, Section II. The numbers 1–7 refer to the questions set; the letters A–E refer to the areas indicated by these letters on the line diagram provided (Fig. 1). H° refers to the position of the houses, a description of which was required in question 7. The column headed M (possible marks) indicates the scoring system, and should be referred to in conjunction with the following analysis, which will be limited, in general, to answers concerning the Polperro picture. In place of individual marks, total scores for each item from one first and one fifth girls' and boys' form taken as random samples have been inserted (labelled G1, B1, G5, B5 in the table), the number of pupils in each class being shown at the top of each column, in brackets.

Answers to question 1 included phrases such as "The tidemark on the wall is higher than the present tide level, and all the boats are

further up the beach to allow for higher tide. So the tide is not at its highest." Recognition of the latter fact scored one mark, each correct reason scored one mark. More revealing are the wrong reasons. "It looks as if it is day-time, and the tide is at its highest in the evening." "If the tide were at its highest, the water would be calmer" or "It must be at its highest otherwise if it were any higher it would cover the houses".

For questions 2, 3 and 6 (areas A, B and E) the answers were analysed under four headings—the land form, an adjective qualifying it; the vegetation cover, and its qualifying adjective. The land at A is "steeply sloping hillside covered with scrubby bushes and/or heath" but the land itself was seldom described, especially by the first three years. Usual comments were "it is rough" or "it is bushy". If the adjective "sloping" was used, this was allowed as a land form, since "What is the land like?" really demands an answering adjective rather than a noun. At B, the hill top, accepted as a plateau, was usually described as "flat" or "grassy". The quality of the vegetation was frequently ignored. At E there is a thickly wooded steep slope. Answers gave "There are trees", "There is dense forest", even the fifth form neglecting the land form; one boy wrote, "It is thick foresty land for pheasant hunting". Question 4, area C, was included for the encouragement of less able children, but again the rocks were seldom described other than as "hard". Several answers referred to seaweed, which was allowed a mark as vegetation. "Bare" was interpreted by the Committee to mean "devoid of vegetation" and also scored a mark, but relatively few children commented on the absence of vegetation.

The explanations of cultivation at D (question 5) are most revealing. Well over 50 per cent of the children say "because it is flat and fertile". The terms are used as if synonymous. Reasons for fertility are added: "The land is fairly near the sea so gets well fertilized". "It is in a valley which makes it fertile." "It is in the country near the sea and a river flows by it so it is fertile." Or, more cautiously, "It is fertile because it has been prepared and must be"—to which is added "There are also hedges round it to keep out dangerous animals". Two main reasons are offered why the land at D is a good place for growing crops: (i) that it is sheltered, and (ii) that it is exposed. If the former: "It is protected from the sea air by the hedges and trees at E" or "It is on the top of a slope which protects it from fierce storms" or "The weather is mostly fine in the southwest of England, and the land is quite flat in this particular position, so crops are quite sheltered from sea breezes". If exposure is favoured: "It is open country and the weather can get at it", "It is high and gets all the rain". The cultivated land at Shieldaig, too, was considered favourable because sheltered by houses and trees, or because exposed to wind, rain and sun. There, however, a further suggestion was frequently ease of irrigation, members of all years suggesting, "It can easily be irrigated by the sea", and even fifth-form boys writing, "It is irrigated for wheat crops".

Most of the children recorded the location of the houses (question 7) as clustered at the water's edge. 20 per cent of the years 4 and 5 commented that they were in a valley, whilst only 9 per cent of these two years recorded that they were at the head of a cove.

Table IV

SHIELDAIG, SECTION III. RESULTS FROM ANSWERS WRITTEN ON LINE DRAWINGS AS PERCENTAGES OF TOTAL NUMBERS OF GIRLS AND OF BOYS IN EACH YEAR

		Girls					Boys				
	Year	1	2	3	4	5	1	2	3	4	5
(a) Shade in areas of flat land	B	99	99	100	100	100	98	99	98	100	100
	D	90	84	86	84	87	69	89	75	86	93
	Rd.	36	38	53	55	54	58	30	39	42	42
	A	1	0	1	2	0	1	1	0	0	0
	F/G	52	50	52	63	48	40	40	37	46	42
	C	22	3	6	12	8	10	4	0	12	0
	E	0	0	1	2	3	1	1	0	0	0
(b) Put S on side from which sun is shining	Top right	72	64	76	74	76	70	69	74	74	78
	Bottom right	17	23	19	7	14	20	14	16	17	20
	Left	11	13	5	19	10	10	17	10	9	2

Table IV gives the results of the answers to Section III of the Shieldaig questionnaire. In question (a) the word "flat" was chosen deliberately by the Committee as of more correct application than "level" or "horizontal", particularly for children. Areas accepted as correct were B, D and the road (Rd. in the table); areas not accepted as correctly shaded are shown beneath these, i.e. A, F/G, C and E. The table shows:

(i) an almost total recognition of the raised beach (B) as a flat area, although its mention as such in undirected search under Section I is very slight;

(ii) an average of 55 per cent of the children failing to record the road as a flat area, either because it escaped their notice or because they may not have regarded it as significant for recording;

(iii) the large percentage of children in each year who shade F/G as being flat or nearly flat. This may be due to over-emphasis on the flatness of cultivated land in school geography;

(iv) a high percentage of children finding the position of the sun accurately. This may be due to the very clear shadows of this photograph, or to practice, since the same exercise had been tried previously, with less success, for the Polperro picture (see Table V).

The results of Section III, Polperro, are recorded in Table V. Areas B and D were accepted as correct, as was the valley floor (Vy. in the table). F, G, H and J refer to areas wrongly shaded, so lettered to enable markers to identify them accurately. F refers to the sloping

headlands in the foreground of A, G to the area behind A, H to the slopes down from B, and J to the slopes in the foreground on the right. The chart shows that although the majority of children recognized D and B as flat areas, very few shaded in the valley floor, possibly because it is largely obscured by houses. Only in year 5 girls was no incorrect area recorded, although only few fifth-form boys shaded the one area, F, incorrectly. The high percentage of children naming correctly foam, a valley, a cliff and a harbour is outstanding. But in the undirected search in Section I, whereas 72 per cent of the children noted the harbour, the other averages are foam 12 per cent, valley 42 per cent, cliff 42 per cent. It seems clear, therefore, that whilst the majority of the children had not recorded these physical features and may not have noticed them, the majority are capable of recognizing and locating them, provided that their attention is drawn to the *existence* of the features, or possibly provided that they are reminded of the *terminology*.

Table V

POLPERRO, SECTION III. RESULTS FROM ANSWERS WRITTEN ON LINE DRAWINGS AS PERCENTAGES OF TOTAL NUMBERS OF GIRLS AND OF BOYS IN EACH YEAR

		Girls					*Boys*				
	Year	1	2	3	4	5	1	2	3	4	5
(a) Shade in areas of flat land	B	94	97	97	97	94	97	98	96	98	99
	D	96	99	98	93	94	97	98	96	92	100
	Vy.	6	7	3	2	6	4	8	10	10	12
	F	1	3	2	7	0	1	1	3	5	4
	G	0	1	1	2	0	7	4	3	1	0
	H	6	3	3	6	0	3	4	3	1	0
	J	6	5	1	2	0	3	1	1	1	0
(b) Put S on side from which sun is shining	Top left	35	45	46	33	59	47	56	56	59	71
	Bottom left	39	38	42	39	25	31	32	34	37	20
	Right	26	17	12	27	16	22	12	9	4	9
(c) Indicate:	Foam	92	75	95	91	90	92	80	98	96	94
	Valley	85	92	89	86	90	87	86	89	92	97
	Cliff	75	82	80	86	88	80	84	87	95	95
	Harbour	80	86	88	89	78	86	87	92	93	99

By the use of these questions in Sections II and III the attention of the children was drawn to those twelve features of the Polperro picture (named in Fig. 3a), and ten features of the Shieldaig picture (named in Fig. 3b), considered by the Committee to be geographically significant. It seemed profitable, therefore, to see if the children had referred to these geographically significant features in their undirected search recorded in Section I. The scripts of Section I were therefore scanned and a record made of specific reference to items such as land-forms, house location and cultivated land. There were now two scores available for each picture, that of the single items originally counted out of twenty, and that of the selected geographical features counted out of twelve or ten.

The differences between these scores were found for each individual, these also giving the mean differences for each group. These are shown in the following table:

	Year	1	2	3	4	5
Polperro	Girls	5·6	6·9	6·5	4·0	4·2
	Boys	5·1	6·3	5·9	3·7	4·8
Shieldaig	Girls	5·0	5·7	6·2	4·2	4·5
	Boys	5·9	5·1	5·6	4·3	4·8

The analysis of variance* was used to establish whether the main difference lay between year-levels or pictures. Although the mean differences were significant for each year, those of years 1, 2 and 3 were significantly different from those of years 4 and 5. It was therefore statistically possible to combine the scores of years 1, 2 and 3 for comparison with those of years 4 and 5 combined. A further statistical test, the t test, was then applied to find whether these group differences were significant for boys and girls, or between pictures, or were only attributable to chance. It was found that the differences between years 1–3 and years 4–5 for both the boys' groups and the girls' groups were highly significant at the 1 per cent level in both pictures, i.e. they could only occur once in every hundred by chance alone.

As Fig. 3a shows, in nearly all cases a greater percentage of older children recorded important geographic features in their undirected search of Section I than did younger children. The exceptions are for the boys: foam; for the girls: rocks and valley. The pattern of percentages is very similar for both boys and girls, most frequent reference being made to the harbour, the location of houses and the rocks; the least frequently mentioned being the state of the tide, the steep scrub or heath-covered slope, the flat areas, the foam, the valley, cliffs and sun. The Shieldaig chart (Fig. 3b) reflects a similar pattern, the exceptions being the tide and areas of flat land for the boys; the tide, beach and house location for the girls. Most frequent reference is made to the beach, the cultivated land and the wooded slope; whilst less frequent reference is made to the state of the tide, the pastures, grassy slopes, raised beach and other areas of flat land.

What these particular children actually saw, undirected and unaided, of geographical significance in these pictures, would appear as follows. In the Polperro picture (Fig. 4) an average of 74 per cent saw rocks, harbour and houses, 43 per cent the valley, wooded slopes and cliffs. The other significant features were apparently lost to them. In the Shieldaig picture (Fig. 5) approximately 70 per cent saw the beach, 65 per cent the location of the houses, 55 per cent the cultivated land, 40 per cent the wooded slope. It does not appear that the eye of the child sweeps, as does that of the geographer, to the 400-ft. platform of the Polperro picture, or to the raised beach of Shieldaig.

* The statistical work was guided by Dr. D. M. Lee, Lecturer in Educational Psychology, University of London Institute of Education, for whose help the Committee wish to record their thanks.

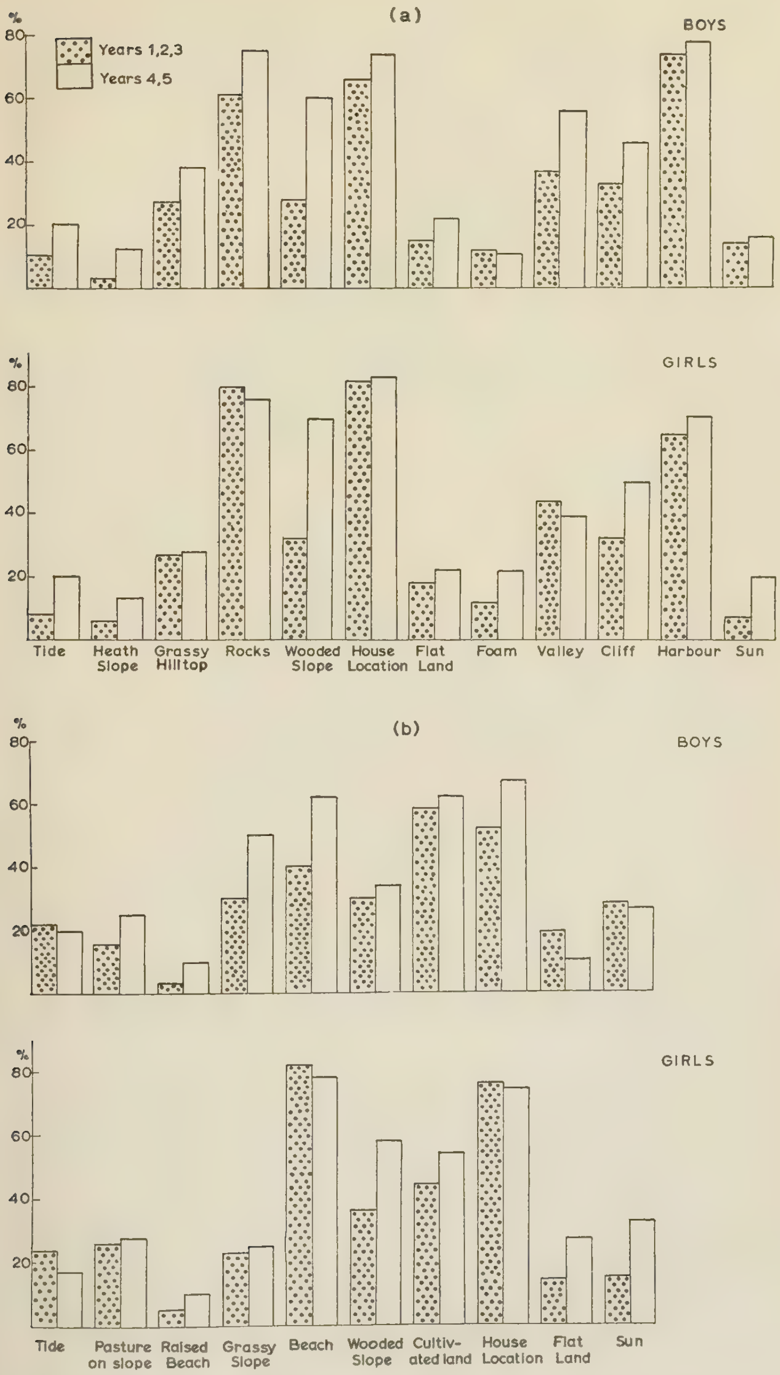

Fig. 3.—Features selected by the Committee as being geographically significant, and recorded by children in undirected search in Section I: (a) for Polperro photograph, (b) for Shieldaig photograph.

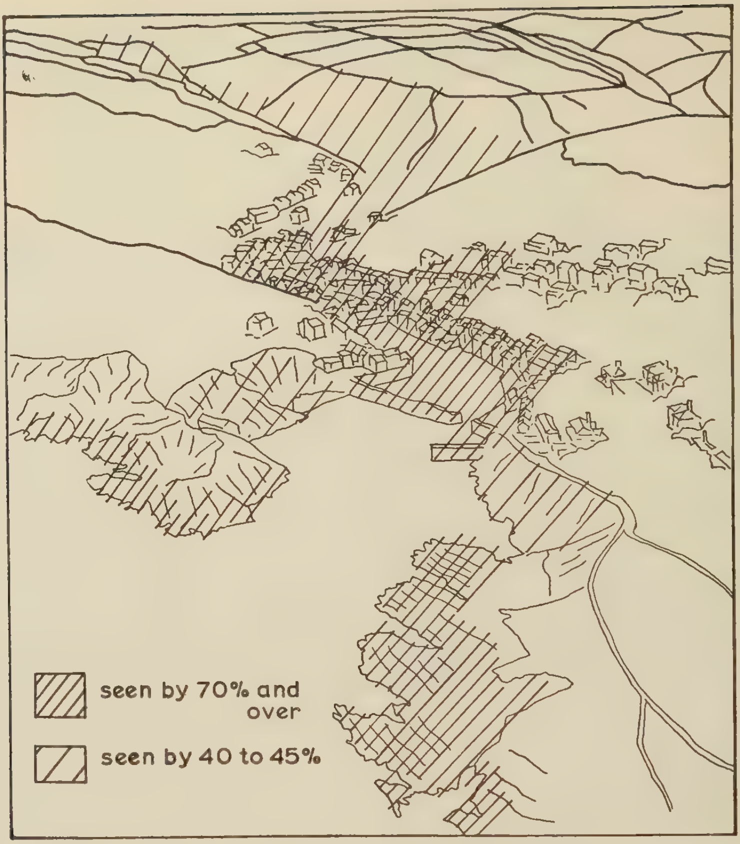

Fig. 4.—Polperro. Areas children appear to see.

A few tentative conclusions from these analyses may be summarized thus:

(i) No one feature is recorded by all the children.

(ii) No one child records, and therefore probably no one child sees, all the features of these pictures.

(iii) Boys and girls, with some minor variations, appear to recognize the same features in these pictures.

(iv) It would appear that more children observe, recognize or record features of human geography than of physical geography in these pictures.

(v) Children of the first five grammar school years are able to recognize a specific physical feature in a picture when invited to search for it, but in free observation they seem less likely to notice it. This phenomenon is by no means so well marked in the case of human features.

(vi) Powers of observation do not necessarily increase with age, but recognition of what is geographically important is significantly greater in years 4 and 5 than in years 1, 2 and 3.

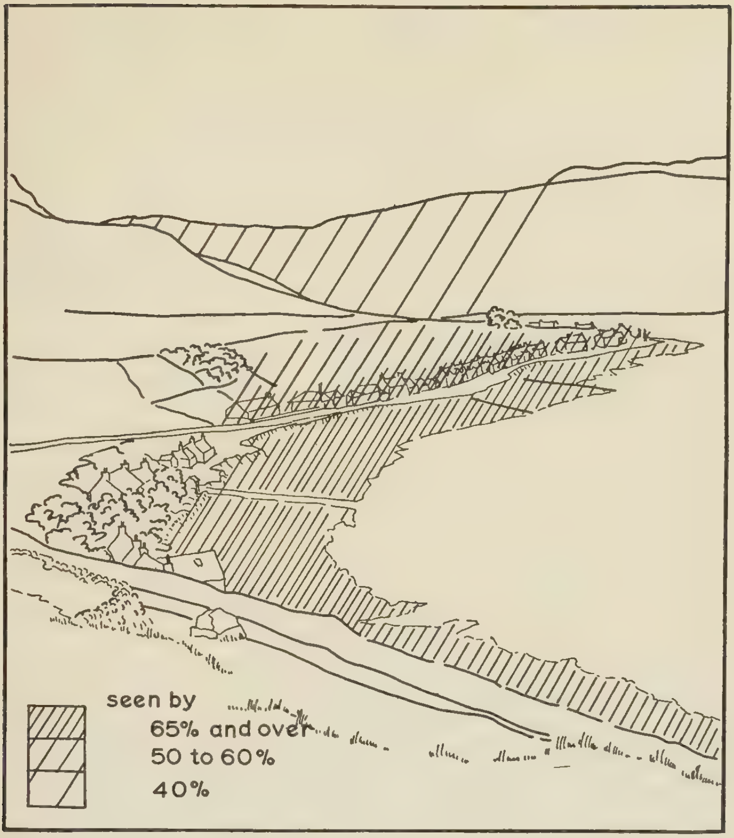

Fig. 5.—Shieldaig. Areas children appear to see.

(vii) This observation, or recognition, may be influenced by two major factors: (*a*) the familiarity of the child with the features and (*b*) the location and emphasis of the feature within the picture itself.

(viii) It would appear that as much as one-fifth of geographical significance escapes the record—and probably the eye—of even the most observant sixteen-year-old, being either not seen, not recognized, not understood, not recorded, or not regarded as worthy of comment.

(ix) Children of all ages are able to discover what is geographically significant in pictures more readily if their search is guided.

A great deal of analysis of the material available remains to be done. For teaching purposes we should be cautious at present in our assumptions of what the children observe. It is apparent that children do not see everything in a picture, and their selection is not necessarily that of a geographer. Given correct guidance, however, there is a marked improvement in their performance.

The Regional Content of Secondary School Geography

J. H. JENNINGS

IT IS CURIOUS that though there has been considerable attention paid to methods of teaching geography, and some consideration of ways of arranging subject matter in a syllabus, there is a reluctance to consider the content of the syllabus itself. What follows is an attempt to open discussion on one important aspect of this subject, the regional* content. The advantages of the present freedom of choice, which, apart from some rigidity arising from the external examinations system, rests with the school, are clear, but several considerations suggest that the question of selection must be considered more carefully than is the case at present.

Even in the five-year course to "O" level it is recognized that there is no value in attempting to cover the whole world by regional treatment, and that some selection must be made. Where four-year or even shorter courses are followed the problem of selection becomes acute, and with the currently increasing use of detail to bring depth to the subject, more and more of the regional cover must be sacrificed. Most schools base their syllabuses on a regional plan, but whether the basis is systematic, regional or concentric, there must be a point at which the regional balance of the course is viewed as a whole.

With these considerations in mind the results of an enquiry into the regional content of secondary school geography in Yorkshire will be of interest. The schools concerned lay in the area served by the University of Leeds Institute of Education, the help of which is acknowledged in the printing and distribution of questionnaires. Only the replies from those schools which kindly sent in very full detail were used, totalling 69 schools in all (35 grammar, 29 modern, 2 technical, and 3 comprehensive). Results came in in terms of weeks actually spent on each region, by all forms except the sixth, during the school year 1959–60. This has been converted into percentages of the grand total time declared as spent on specifically regional work (i) by all 69 schools, (ii) by the 35 grammar schools separately, (iii) by the 29 modern schools separately. The units of time on which the percentages were calculated were stream/weeks, where a stream numbered about 30 pupils, and where a week was one in which $1\frac{1}{2}$ to $1\frac{3}{4}$ hours were spent on the study of geography; adjustments were made for significantly

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* The word "region" here is used in a broad sense to include any compact area of the world which is considered to form a convenient unit for school geographical study. In practice these units are usually closely related to political boundaries.

larger or smaller classes and for unusually large or small amounts of time spent studying the subject. The grand totals for grammar and for modern schools calculated in this way were approximately equal, so that the combined percentages (the first column in the tables) are not unduly weighted to one type of school. Details of time spent on systematic or world geography were not asked for in the questionnaire and as there probably was a greater tendency for schools concentrating more on these aspects of geography not to return a questionnaire the proportions of total time spent on regional and on systematic geography have not been calculated.

Table I

TIME SPENT IN STUDYING THE MAJOR WORLD DIVISIONS, EXPRESSED AS A PERCENTAGE OF THE GRAND TOTAL TIME

	All Schools	*Grammar*	*Modern*
British Isles ..	28·4	25·8	30·5
Europe, without Russia	15·5	15·8	16·3
USSR	1·7	0·9	2·1
Rest of Asia ..	10·1	10·5	10·3
Africa	10·0	11·0	8·4
Australasia ..	10·1	10·2	9·6
North America ..	16·3	16·4	16·5
South America ..	7·9	9·3	6·2
Antarctica ..	—	—	0·1

Table I shows the results of the enquiry in outline, and indicates that the study of the homeland takes up between a quarter and a third of the regional time, and the study of our neighbours, in Europe and North America, together, slightly more. The other "continents" were treated unevenly, with Australasia very well covered and at the other end of the scale the Soviet Union neglected. If this pattern is regarded as unsatisfactory then the problem of selection is immediately acute. If, for instance, it is thought that the Soviet Union should receive more attention, then the necessary time must, in terms of percentages, be taken from other regions.

Table II gives the findings in greater detail—too much reliance cannot be placed on the smaller items in the grammar and modern columns in view of the smaller sample from which the figures derive, but many points of interest do arise. The amount of time spent on studies located in the Commonwealth, but outside the British Isles, can be estimated from the table as 21 per cent, plus time hidden in the figures for the general cover of continents (e.g. much of the time spent on Asia will have related to India). Some areas which have particular social, economic and political ties with us received generous treatment, such as New Zealand, which received as much time as Scotland and Ireland together, and Australia and Canada, each of which attracted about as much time as the geography of Northern England. Yet others were treated very briefly despite their great significance to us as a nation. Southwest Asia, of great strategic and economic importance to us, received only a half of one per cent of the time; the West Indian

Federation, the origin of many of our immigrants, received less than half of one per cent (it would be reassuring if it were found that schools in parts of London or Birmingham gave the study of the Caribbean a more important place in their syllabuses). Countries of great present-day significance in world affairs may likewise be neglected. In addition to the Soviet Union, already mentioned, we can note the poor treatment of China, with about 20 per cent of the world's population, receiving only 1·4 per cent of the time. The state of Israel, a fascinating and surely important field for studies in historical and modern geography, was completely ignored in every school but one of those which replied.

If grammar and modern school figures are looked at comparatively, further points of interest emerge, for example the greater time allotted to the local district in modern schools.*

Modern schools also spent rather more time studying the Soviet Union, and more on the British Isles. Grammar schools made this up by spending more time on the study of the three southern continents. It will be realized that the figures hide a very wide variation of emphasis from school to school in each group.

It might be argued that with any selection of regions there would always be criticism, and that the pattern which emerges from the enquiry represents the application of priorities which are, in the absence of any agreed set of values, as valid as any other pattern. Yet, if we consider the areas emphasized and the areas neglected, as noted above, it is difficult to avoid the conclusion that the accepted priorities were quite inappropriate to 1960, even if justifiable a quarter of a century ago. The regional balance pertains to an era when the British Commonwealth meant primarily the white Dominions, before the power of the Soviet Union had been felt, or the people of China counted and organized. Meanwhile the world changes, and at a rapidly accelerating pace; surely the question of what to teach needs a careful answer if geography is not to join history as a study set in the past.

Table II

TIME SPENT IN STUDYING THE DIFFERENT REGIONS, EXPRESSED AS PERCENTAGES OF THE GRAND TOTAL TIME

	All Schools	*Grammar*	*Modern*	*Notes*
British Isles	13·81	10·56	16·29	general cover of the region as a whole.
Great Britain	1·09	1·01	1·32	general cover of the region as a whole
England and Wales	1·07	1·09	1·00	general cover of the region as a whole
The Local District	2·86	0·83	4·17	area varies from school to school
Northern England	4·33	5·43	3·64	Cheshire, Derbyshire, Notts., and northwards

* The percentages refer only to time spent within the framework of the normal timetable; information about school journeys was not normally given in the returns.

Table II—continued

	All Schools	*Grammar*	*Modern*	*Notes*
The Midlands, East Anglia and Lincs.	1·10	1·58	0·81	
London and the Southeast, plus Hampshire	1·29	1·64	0·97	
The Southwest Peninsula	0·39	0·64	0·22	
Wales	0·68	0·85	0·57	
Scotland	1·22	1·48	1·04	
Ireland	0·54	0·71	0·46	
Total	28·39	25·83	30·47	
Europe	6·40	6·59	6·32	general cover of the continent as a whole, including Russia but not the British Isles
Northern Europe	2·18	2·08	2·54	
Central Europe	1·94	2·05	2·05	Germany, Switzerland and the Alps
Western Europe	2·79	2·86	3·05	France and the Low Countries
Southern Europe	1·78	1·61	2·14	
Eastern Europe	0·39	0·62	0·21	
Total	15·48	15·83	16·31	
USSR	1·69	0·93	2·06	a fraction of the general cover of Europe and Asia will also refer to the USSR
Asia	3·60	3·81	3·22	general cover of the region as a whole, including the USSR in Asia
Japan	0·91	1·13	0·81	
China	1·36	1·40	1·48	
Southeast Asia	1·16	0·98	1·47*	* mostly Malaya
The Indian sub-continent	2·49	2·56	2·72	
Southwest Asia	0·56	0·60	0·59	
Total	10·08	10·50	10·29	
Africa	5·32	5·78	3·82	general cover of the continent as a whole
The Maghreb	0·16	0·29	0·05	
The Sahara	0·46	0·64	0·34	
The Nile Basin	0·65	0·78	0·61	these areas overlap
East Africa	0·43	0·57	0·35	these areas overlap
The Rhodesian Federation	0·23	0·29	0·18	
South Africa	1·45	1·29	1·77	
The Congo Basin	0·31	0·41	0·26	including Equatorial Forests in Africa when studied as part of a course on Africa
West Africa	0·95	0·97	1·05	
Total	9·96	11·04	8·44	
Australasia	2·72	2·97	2·81	general cover of the region as a whole
Australia	5·65	5·22	5·17	
New Zealand	1·71	1·91	1·58	
Oceania	0·04	0·05	0·04	
Total	10·13	10·15	9·61	

Table II—continued

	All Schools	Grammar	Modern	
Antarctica	0·03	—	0·07	only one school declared any study of this region
North America	6·66	5·64	6·81	general cover of the continent as a whole
Canada	4·10	4·75	3·97	
United States	4·92	5·29	5·15	
Central America	0·21	0·32	0·16	including Mexico
The Caribbean Islands ..	0·41	0·42	0·45	mostly the British West Indies
Total	16·30	16·43	16·54	
South America	5·10	5·67	3·86	general cover of the continent as a whole
Brazil	0·89	1·13	0·76	
Argentina and Uruguay ..	0·75	0·81	0·78	
Chile..	0·51	0·60	0·49	
Bolivia, Peru, Ecuador, Colombia, Venezuela and the Guianas	0·66	1·09	0·31	
Total	7·90	9·30	6·20	

The Role of Geography in Technical Education

At the Annual Conference at the London School of Economics and Political Science, on 2nd January, 1961, the Further Education Section of the Association sponsored a discussion on the present status and future role of geography in Technical Education. The opening paper, printed below, was delivered by Professor M. J. Wise. In the discussion which followed this paper general support was forthcoming for the view that the Association should do more to advance the claims of the subject for a stronger role in further education.

It was widely felt that among the steps that could be taken were:

(*a*) The giving of assistance to professional bodies in the revision and co-ordination of geography syllabuses.

(*b*) The provision of advice and encouragement by the Association to those G.C.E. examining bodies interested in providing syllabuses suited to the needs of students in institutes and colleges of further education.

(*c*) The provision of general support to the Further Education Section who were endeavouring to secure improved conditions and opportunities for geography lecturers. It was suggested that the Section could produce model syllabuses for courses of various types. The Executive Committee of the Association has subsequently agreed to consider sympathetically any proposals requiring its support that the Section may bring forward.

(*d*) That the Association should take all possible steps both to urge and to demonstrate practically the importance of including geography as a subject in its own right in colleges of technical and commercial education of all levels.

Of all the problems that today confront the Geographical Association, and indeed all who are interested in geographical education, that of placing the subject in its proper role in technical education is one of the most important. It is unnecessary to detail the vast developments that are in train, and are planned for the immediate future, in technical education at home and abroad.[1] It is widely recognized that the continuance not only of our industry, agriculture and trade, but also of our standards of living and ways of life depends upon the rapid advancement of production and distribution techniques, which themselves must rest upon fundamental scientific advances. Technologists and technicians are needed in large numbers to apply scientific advances to economic and social needs. Where is the most useful role for geography, and in what ways can the Geographical Association best help? These tasks are, surely, so important for the subject, and for the nation, as to necessitate the attention and co-operation of the whole Association. Up to the present time the tasks have been the responsibility only of the members of the Further Education Section of the Association. As a non-member of that Section I should like, at once, to pay a tribute to its members for the valuable work that they have done towards arousing in the minds of some of us an appreciation of the new demands facing the subject and the Association.

The Further Education Section was brought into existence less than ten years ago to help teachers engaged in the distinctive field of geographical education in Institutes of Further Education: teachers whose problems are, without doubt, more varied and more difficult than are those of the majority of teachers in universities, training colleges, secondary and junior schools.

As evidence of the value of the work achieved by that Section in its short life, I point to the report on "Geography in Institutes of Further Education" published in *Geography*, vol. xli in July 1956. This report was based on a sample investigation into the position of geography in the 535 institutes of further education in England, ranging in size and character from the small local institutes concerned principally with part-time, and usually evening, courses, to the large technical colleges drawing students from a wide area, or even region, and providing a varied range of full- and part-time courses up to external degree standard. In about two-thirds of the 535 colleges reasonable opportunities for geographical work were shown to exist. The further results of a more detailed enquiry into conditions in 50 representative colleges revealed a decidedly unhappy picture. About 50 per cent only of the institutes possessed full-time lecturers in geography: in some of the smaller ones the amount of work was said to be too small to justify a specialist geography appointment. But specialist appointments were also absent in some of the larger colleges, and in some cases the geography specialist had insufficient work in geography and was required to assist in teaching other subjects. There was a feeling also that, although the majority of the geography specialists were adequately qualified, further education had not yet succeeded in securing the best possible men and women to promote the subject in a difficult environment. In part this is due, no doubt, to the fact that the development of geography in many institutes is a relatively recent phenomenon, often of post-war origin. The complaint that "geography is not a saleable subject" was not infrequently received from principals, but

was answered effectively by evidence that the appointment of competent geography specialists found a quick response in mounting numbers of enthusiastic students and increasing numbers of courses and classes. Little research was being done by lecturers in institutes of further education, even in institutes where external degree courses were being offered. Accommodation, library, map and other facilities were, with some exceptions, far from adequate to meet teaching needs. The modified optimism of the report ". . . Geography is gradually finding a place and a position of respect in the Institute of Further Education . . ." seems hardly justified in the light of later comments ". . . In only relatively few colleges may geography be said to be well established with a fully trained geographer in charge with a full range of work . . . and with a geography room adequately equipped. In most colleges the geography department, if it exists, is weak and something of a Cinderella; in some it seems to be only there on sufferance."

In view of the current interest, and current investment, in institutes of further education, this report should have proved of a distinctly disquieting nature and it is disappointing that its publication aroused little comment in the journal of our Association. It is true that, in April 1957, the Association, submitting a report[2] on "The Place of Geography in the Education of Boys and Girls of 15 to 18 Years", strongly urged the importance of geography, asked for a much wider recognition of the subject's value and insisted on its inclusion amongst the courses available in all institutions concerned with further education.

A little later, in June 1958, the Royal Geographical Society also issued a powerful memorandum, urging the inclusion of geography in technical college courses on grounds of the value of the subject as a liberal study, its key position as a linking subject and its direct relevance to technological studies.[3]

These reports present, in general terms, a good case for the development of geographical teaching in technical colleges of various grades. They indicate a line of progress, but leave unresolved the difficulties of implementation. The way of achievement is shrouded in the fog of educational diplomacy. Advances have indeed been made since 1957 but it can hardly be denied that the rate of advance has been slow. Surely, the Geographical Association, having helped to guide the subject in its growth in the universities, training colleges and secondary schools, must now devote more of its resources and thought to the technical colleges.

Much must, of course, be left to the initiative of the individual lecturer. But I suspect that too much is being asked of the individual lecturers and teachers in further education, and that the Association is failing to organize both ways and means. It may be worth while to examine, for a moment, the very varied range of work that falls to the lot of the average lecturer in a technical college. Mr. Wallace, Dr. Robinson and others had told me of the work of the technical college lecturer: as they put it, a challenging but also a confusing lot. Unwilling to accept hearsay evidence, I went for myself to a large technical college in the London area where Mr. H. K. Hickling and Mr. J. A. Dennis very kindly took me at length through the work of the college and the role of the geography lecturer. Despite the size of the college (some 10,000 registered students) and the presence of a sympathetic principal, only about two-thirds of the geography specialist's time is devoted

to geography teaching; the rest is spent on other subjects, including geology. That two-thirds is devoted to no less than seven different types of course:

(1) full- and part-time classes for "O" Level,
(2) full- and part-time classes for "A" Level,
(3) courses for the Diploma in Marketing, mainly in economic geography,
(4) courses for the Diploma in Banking, into which some students for the Institute of Export and Institute of Transport examinations are also fitted,
(5) a one-year intensive course for girls of 16 years and over undertaking secretarial courses,
(6) courses in geography as part of the liberal studies programme for students of "technical" departments,
(7) courses for students reading for B.Sc.(Econ.) degree examinations with geography as the special subject.

In addition, the lecturer, as befits a man teaching degree students, does his best to find time to pursue research work on the industrial geography of a nearby area, with a view to taking a higher degree of the University of London.

It will be clear that a man with so many commitments, each demanding its own quota of thought, preparation, teaching and marking, is in no easy position. He may well be in a quandary as to whether to attempt to advance his subject along all possible paths or to attempt a specialized advance, relegating certain courses and student groups to a position of lower importance. Almost certainly the decision is made for him by the constant pressure of classes, students, day work and evening work and by his own struggle to keep up to date. Is this the kind of post likely to attract the best geographers and the best teachers? But our Further Education Section tells us that the progress of our subject in further education rests very much with the quality of the lecturer in charge.

This situation may be eased a little as the new pattern of technical education emerges, in which eventually there will be, to a greater extent, a concentration of different levels of work in local colleges, area colleges and regional colleges. Greater specialization will thereby be encouraged and much existing duplication of courses avoided. A practicable method of easing that part of the task that concerns courses for professional examinations must also be sought. According to a recent count, at least 30 professional bodies include geography, either as an optional or a compulsory subject, at some stage of their examinations. Many of the syllabuses are similar in general character, especially in economic and commercial geography, but sufficiently divergent in their stipulations to make the provision of common courses a very difficult task. Here lies a possible role for the Geographical Association. Could not representatives of the various examining authorities be brought together? It is surely possible to provide for the special requirements of each profession while eliminating many, if not all the minor differences which add, out of all proportion, to the daily difficulties of the lecturer's task. It may well be, also, that advice from the Association could help the professional bodies to inject new life into their syllabuses; a brief review of some of them suggest that a little liberalization of outlook, perhaps a little relevant field and practical work, would be to the advantage both of the professions and of the candidates.

We have mentioned some of the practical difficulties of the man in the college. It is clear that it is asking too much to place entirely on his shoulders the responsibility for the progress of geographical studies in technical education. Planning is called for, and the Geographical Association is the body best fitted by membership, experience and outlook to undertake this task. I have heard it argued that technical education is, after all, only of marginal interest to the Geographical Association since but a very small percentage of the Association's membership is represented by teachers in institutes of further education: further, that only a proportion of geography teachers in those institutes are members of the Association. This is no answer. The interest of the Association is the strengthening of geographical education in all types of institute and school, and outside them, too, in public life, in office, factory, and in the home. The Association must seek immediately to enrol as members all geography lecturers in further education institutes. In the light of its historic role as the mainspring of the principles and practice of geography teaching, it cannot now neglect new opportunities to promote learning in the subject.

It is noticeable that in the two memoranda of which I spoke (i.e. by the Association to the Central Advisory Council and by the Royal Geographical Society), the strength of the case rested on the value of the subject in *two* principal ways.

First, there is the value of geography in the liberal education of the technical student. "The characteristic geographical method is such that it may well commend itself to the technologist who is seeking to expand his mental horizons", say the Education Committee of the Royal Geographical Society. At least a quarter of the time spent in preparing for the Diploma in Technology is to be spent on liberal studies, and it is clear that geographical courses can be very appropriate, indeed necessary.

Secondly, geography is said to have a role as a background subject for students undertaking vocational courses, for example, in building trades, engineering, transport, nursing, secretarial work. This is an important task and, so far as can be judged, lecturers in technical colleges are shaping excellent courses in, for example, the geography of resources, industry, transport, even in medical geography, to suit the interests of these students and at the same time to give them real insight into geographical thought and method. But I have no doubt that the field needs considerable extension, especially in the field of what is commonly called commercial education. It can be argued that, at the present time, progress in the more narrowly technical fields of education, in applied science, is leaving far behind the slower progress of commercial education.[4] The need for geography as an essential ingredient in a business or commercial education was being preached 90 years ago at least. At the turn of the century, Herbertson was preaching a geography "applied to commerce". We must not only produce; we must distribute our product, sell it, trade it. A renaissance of education in the arts of trade and in the relevant disciplines of study is overdue; it must spring from work in institutes of further education, perhaps through the teaching, in new ways, of what is academically called regional economic geography.

Both these aims are proper and good ones, but it is possible that a third, and even more important, aim has not yet been openly stated. Surely

greater emphasis should be placed on the role of geography in further education for what it is rather than merely for the background it can provide to practitioners of other subjects and trades. It is a part of our general belief in the Association that geography is a subject with techniques of its own which are capable of application to the betterment of the lives of our own countrymen and of men in other lands. Should we not offer these techniques and their achievements as evidence that geography has a rightful place of its own, not merely as a background subject, in technical education at all levels, not excluding the Colleges of Advanced Technology? I believe that we should now be giving serious consideration to the possibility of advancing the claims of geography in these terms.

Clearly, much thought must be given to the definition of the purpose of technical courses in geography and to the scope and nature of the work to be offered. Here I feel bound to disagree with the view expressed in the Association's memorandum that "geography as a subject in further education can be fundamentally the same as geography in secondary schools". This cannot be, for in further education the approach and content must be regarded from the point of view of very different needs and uses and with a quite separate group of students in mind. These are students of varied ages and abilities but who, generally speaking, prefer to study problems and techniques that have application to material things and questions of current interest; they include also students who, for one reason or another, have developed a bent towards education at a later than usual stage. In the Geographical Association we have surely advanced far from the view that there is only one kind of geography to be taught to students of all types. Such a view, if still held, does harm to the subject. There are many paths to the geographical view; it is the way of looking that matters, not the uniformity of the facts surveyed. The Geographical Association has a duty to perform in suggesting approaches to geographical studies suitable for development in technical colleges. The duty is first that of the Association; second that of examining bodies for the General Certificate of Education who, through their syllabuses, influence directly the nature of courses provided. It can only be a mistake to try to tie technical students to syllabuses laid down primarily for grammar school pupils. We must note with interest the initiative of the Associated Examining Board whose new syllabus for "O" Level, while demanding as fundamental a grasp of basic geographical principles as does any other Board, enables students and teachers to develop interest and reality in the subject through a special treatment of a selected aspect; for example, the geography of industry and commerce, or of agriculture.

Not only must we relate the subject to needs, but we must teach it practically. This is not easy to put into effect in view of current shortages of equipped geography rooms. But once it has been demonstrated beyond reasonable doubt that geography needs its benches, its drawing-boards and its instruments, they will come in all colleges. Students must not merely read about maps, they must make maps. We should be sending out into offices and factories men and women who can plot distributions, analyse them and show the relevance of the distributional approach to industrial and commercial problems to which they are applicable. Let me give one small example. Here, in the London School of Economics, Dr. K. R. Sealy,

working on geographical aspects of air transport, has had no difficulty in interesting the air lines and aircraft firms in his methods, and they have been quick to see the value to them of his results and to support his work. In other fields of study, Professor Stamp has shown the way.[5] The techniques of mapping, survey and analysis cannot be acquired by reading about them. They must be performed. Geographical laboratories and workshops have an integral part to play. Geography is a practical subject; let it become one in reality in further education.

You will see that I wish to change the emphasis of the argument for geography as a subject in further education. Let us base our arguments not on the side-door entry of geography as a general education for citizenship, and as a background subject but, through the front entrance, on geography as a disciplined, practical study, with its own techniques and tools directly applicable to the problems and tasks of the day. It is becoming increasingly clear that each advance in industrial or engineering technique brings in its train consequences for the use of land, for the distribution of employment and population, for the employment of newly created resources and locational values. The present dramatic changes taking place in the geography of our own country, especially in southeastern England, are evidence enough without traversing abroad. Geography has techniques which may be used to chart and to guide these changes if only we will sharpen them, learn them, teach them and practise them. Let us make geography a subject which does things, not merely one which reads about other people doing them.

Here is the great challenge to our subject: here will be its new contribution. We must always remember that the pupils of today are the teachers and leaders of the first years of the twenty-first century, not the sons and daughters of the nineteenth.

Many of you may know a booklet entitled *Pathway to the Future*, a guide to further education in one of the great counties of the London Region. There are many like it for other counties and county boroughs. In it geography finds a place—four and a half lines of small type refer to courses for "O" and "A" Levels at certain centres, and to one or two other minor courses. Do we not all believe that geography is a pathway to the future, that it can assist in the re-moulding of town and country, land and landscape, the re-shaping of patterns of life for the era of technology? Let us show and prepare the way that others may follow.

REFERENCES

1 See, for example, *Better Opportunities in Technical Education*, Cmnd. 1245, H.M.S.O., London, 1960.
2 "The place of geography in the education of boys and girls of 15 to 18 years", *Geography*, vol. xlii, July 1957, pp. 174–81.
3 "Geography and technical education", *Geographical Journal*, vol. cxxiv, June 1958, pp. 232–4.
4 Government plans announced following the *Report of the Advisory Committee on Further Education for Commerce*, 1959, envisage considerable progress in commercial education though it is to be doubted whether they are adequate to match plans for "technical" education. No cause for complacency exists on the status of geography.
5 See, for example, L. Dudley Stamp, *Applied Geography*, Pelican Books, London, 1959.

Chairs of Geography in British Universities

It has been felt that a record should be made concerning the foundation of chairs of geography in British universities and the list below attempts to provide such a record. The professorships are listed in chronological order of institution on a permanent basis, permanent, that is, from the date given up to the present time. Professors had, in some cases, been appointed previously, but the chairs had lapsed or the appointments had been personal ones only. These early appointments are mentioned in each case of which details are known.

This list has been compiled for the Association by the Chairman of Council, Professor H. J. Fleure, and the details given have been corroborated or corrected by the present heads of departments and by university registrars.

1903 University of London, University College. L. W. Lyde was appointed professor of economic geography. Captain Maconochie had held a professorship of geography during 1833–6 and was the first professor of geography in the United Kingdom. C. B. Fawcett became professor of economic geography in 1928; his title was changed to "Professor of Economic and Regional Geography" in 1931 and to "Professor of Geography" in 1944. H. C. Darby became professor of geography in 1949. Honours courses in geography for the degrees of B.A. and B.Sc. were instituted in 1919. Courses in geography for the degree of B.Sc. (Econ.) were instituted in 1912.

1917 University of Liverpool. P. M. Roxby was appointed John Rankin Professor of Geography, and Honours courses in geography for the degree of B.A. were instituted. He had been an assistant lecturer in the subject from 1905 and a lecturer from 1908. Roxby resigned in 1944; H. C. Darby was professor from 1945 to 1949 and Wilfred Smith from 1950 to 1955. R. W. Steel became professor in 1957. B.Sc. Honours degrees were instituted in the session 1953–54.

1917 University College of Wales, Aberystwyth. H. J. Fleure was appointed Gregynog Professor of Geography and Anthropology. He had been lecturer in charge of the subject since 1907. Honours courses for the degrees of B.A. and B.Sc. were instituted in 1918. C. D. Forde became professor in 1930 and E. G. Bowen in 1946.

1922 University of London, London School of Economics. Sir H. J. Mackinder was appointed professor of geography. The subject had been taught for the B.Sc. (Econ.) and for the Academic Diploma in Geography by an independent reader since 1900, and an Honours school in the Faculty of Arts was instituted in 1918 jointly with King's College. In 1925 Ll. Rodwell Jones succeeded Mackinder as professor and was himself succeeded in 1945 by L. Dudley Stamp. In 1949 Stamp was translated to the Chair of Social Geography (a new chair)

and R. O. Buchanan became professor of geography. In 1958 when Stamp retired, the Chair of Social Geography was not filled, and M. J. Wise was appointed to a new chair of geography. Buchanan retired in 1961 and was succeeded in the chair of geography by Emrys Jones.

1922 University of London, Birkbeck College. J. F. Unstead was appointed professor of geography. He had been lecturer and head of department since 1920. Eva G. R. Taylor became professor in 1930, S. W. Wooldridge in 1944 and W. G. East in 1947.

1927 University of Exeter (then University College of the South West). W. Stanley Lewis was appointed to the Reardon Smith Chair of Geography. He had been lecturer and head of department since 1920, following W. W. Jervis. P. W. Clayden had lectured in geography at an earlier period. Honours courses were instituted for University of London degrees in the Faculties of Arts, Science and Economics in 1922. Arthur Davies became professor in 1948.

1930 University of Manchester. H. J. Fleure was appointed professor of geography. A lectureship in political and commercial geography was established in 1892, held first by H. Yule Oldham and later by A. J. Herbertson (1894–6). J. McFarlane was lecturer in economic and political geography (1903–8) and lecturer in geography (1908–19). A. G. Ogilvie and W. H. Barker were readers and heads of the department from 1919 to 1920 and from 1922 to 1929 respectively. Honours courses in the Faculty of Arts were instituted under W. H. Barker in 1923. W. Fitzgerald was professor from 1944 to 1949. P. R. Crowe became professor in 1953.

1931 University of Cambridge. F. Debenham was appointed professor of geography. F. H. H. Guillemard (lecturer 1888), H. Yule Oldham (lecturer, then reader 1889–1908), P. Lake (reader and head of department 1919–27) and F. Debenham (1927–31) had previously had charge of the subject. Examinations in geography for the ordinary B.A. degree and for the diploma in geography were established in 1903; Honours courses were instituted in 1919. J. A. Steers became professor in 1949.

1931 University of Sheffield. R. N. Rudmose Brown was appointed professor of geography. He had been lecturer and head of department since 1908. Honours courses in the Faculty of Science were instituted in 1924, in Arts in 1926 and in Economic and Social Studies in 1961. D. L. Linton was professor from 1945 to 1958 and C. A. Fisher became professor in 1959.

1931 University of Edinburgh. A. G. Ogilvie was appointed professor of geography. G. G. Chisholm (1908–29) and A. G. Ogilvie (1929–31) had previously been lecturers and heads of department. Honours courses in the Faculty of Arts were instituted in 1930 and a post-graduate diploma (post-M.A.) course was established in 1958. J. W. Watson became professor in 1954.

1932 University of Oxford. K. Mason was appointed as first statutory professor of geography; the chair was attached to Hertford College.

(Sir) H. J. Mackinder had had charge of the subject, as reader in geography, between 1887 and 1905. A school of geography, with three members of staff, was established in 1899, the first in Britain. The offices of reader in geography and director of the school were held by A. J. Herbertson (1905–15) and by H. O. Beckit (1919–31). A. J. Herbertson also held the personal title of professor from 1910 until his death in 1915. The Honour school of geography was established in 1932. E. W. Gilbert became the second statutory professor of geography in 1953.

1933 University of Bristol. W. W. Jervis was appointed professor of geography. He had been lecturer and head of department since 1924 and reader since 1926. Honours courses for the degree of B.A. were instituted in 1924 and for the degree of B.Sc. in 1932. R. F. E. W. Peel became professor in 1957.

1943 University of Reading. A. A. Miller was appointed professor o geography. He had been independent lecturer since 1936 and joint lecturer in charge between 1926 and 1936. H. N. Dickson had been professor of geography from 1907 to 1920. Sir H. J. Mackinder had lectured in geography when he was Principal of University College, Reading; he resigned in 1903. Honours courses were instituted in the Faculty of Arts in 1926 and in the Faculty of Science in 1929.

1943 University of Durham, King's College, Newcastle-upon-Tyne. G. H. J. Daysh was appointed professor of geography. He had been lecturer in charge of the department, which was founded in 1928, since 1930 and reader from 1939. Honours courses for the degrees of B.A. and B.Sc. were instituted in 1930.

1944 University of Leeds. A. V. Williamson was appointed professor of geography; he had been head of the department since 1928. Ll. Rodwell Jones was assistant lecturer in geography in the department of economics, 1912–19, and C. B. Fawcett was head of the department of geography, 1919–28. The department was founded in 1919 with an Honours school in the Faculty of Arts; an Honours school in the Faculty of Science was added in 1954. R. F. E. W. Peel was professor from 1953 to 1957 and R. E. Dickinson became professor in 1958.

1945 Queen's University of Belfast. E. Estyn Evans was appointed professor of geography. He had been independent lecturer since the foundation of the department in 1928 and was made reader in 1944. Honours courses for the degree of B.A. were instituted in 1931 and for the degree of B.Sc. in 1935.

1947 University of Glasgow. A. Stevens was appointed professor of geography. He had been lecturer and head of department since 1918. The department was founded in 1909 and previous heads of department were (Sir) H. G. Lyons and J. D. Falconer. Honours courses for the degree of B.Sc. were instituted in 1912 and for the degree of M.A. in 1947. R. Miller became professor in 1953.

1947 University of London, King's College. S. W. Wooldridge was appointed professor of geography. He had been lecturer in charge of the subject 1925–44. W. Hughes had been professor of geography

1863–76 and H. G. Seeley was professor of geography 1876–96 and of geography and geology 1896–1909. (Sir) T. F. Sibly succeeded to the headship of the department of geology in 1908 and W. T. Gordon became professor of geology and administrative head of the department of geography when joint work with the London School of Economics began in 1918. The present department was founded in 1920 and Honours courses for the degrees of B.A. and B.Sc. were instituted in 1921.

1948 University of London, Bedford College. Gordon Manley was appointed professor of geography. Miss B. Hosgood had been lecturer, then reader (1923), and head of the department since its foundation in 1919 when Honours courses for the degree of B.A. were instituted. Honours courses for the degree of B.Sc. were begun in 1925.

1948 University of Birmingham. R. H. Kinvig was appointed professor of geography. He had been reader and head of department since its institution in 1924. Honours courses in the Faculty of Arts were instituted in 1926, in the Faculty of Science in 1938 and in the Faculty of Commerce and Social Science in 1946. D. L. Linton became professor in 1958.

1949 University of Nottingham. K. C. Edwards was appointed professor of geography. He had been independent lecturer in geography since 1934, and reader and head of department since 1939. Honours courses were instituted in the University College of Nottingham for University of London degrees of B.A. and B.Sc. in 1924 when Professor Swinnerton was made head of the department in addition to his previous responsibility as professor of geology. Honours courses were included in the Faculty of Law and Social Science in 1958.

1950 University College of North Staffordshire. S. H. Beaver was appointed professor of geography. The department was set up when the University College was founded and Honours courses for the degree of B.A. in the groups Humanities, Social Studies and Science were instituted at the same time.

1951 University of Aberdeen. A. C. O'Dell was appointed professor of geography. He had been lecturer and head of department since 1945. The department was founded in 1919 with J. MacFarlane as lecturer, later reader, and head of department. Honours courses for the degrees of M.A. and B.Sc. were instituted in 1922.

1954 University of Southampton. F. J. Monkhouse was appointed professor of geography. The department was founded in 1913 in the University College of Southampton and its successive heads of department have been C. B. Fawcett (1913–20), W. H. Barker (1920–2), O. H. T. Rishbeth (1922–38) and Miss F. Miller (1938–54). Honours courses were instituted for University of London degrees of B.A. and B.Sc. about 1918.

1954 University College of Swansea, University of Wales. W. G. V. Balchin was appointed professor of geography. Geography had been taught in the College from its foundation in 1920, first in the department of geology by A. E. Trueman and S. W. Rider. The first full lecturer in charge of

geography in a newly named department of geology and geography was D. Trevor Williams (1931–46), followed by B. H. Farmer (1946–8) and J. Oliver (1948–54). Honours courses for the degrees of B.A. and B.Sc. were instituted along with the creation of a separate department of geography in 1954.

1954 University of Hull. H. King was appointed professor of geography; he had been head of department since 1928. Honours courses for University of London degrees of B.A. and B.Sc. were instituted in the University College of Hull in 1928; and for the B.A. and B.Sc. degrees of the University of Hull in 1954. H. R. Wilkinson became professor in 1958.

1954 University of Leicester. N. Pye was appointed professor of geography. P. W. Bryan had been appointed lecturer in the University College of Leicester in 1922 and was made professor in 1953. Honours courses for the University of London degrees of B.A. and B.Sc. were instituted in 1922 and 1925 respectively. Honours courses for the degree of B.A. in the Social Sciences began in 1957.

1956 University of Durham, Durham Colleges. W. B. Fisher became professor. G. Manley (1928–38) and L. Slater (1938–47) successively held the position of lecturer, the latter also as reader (1947–53), in charge of the subject. W. B. Fisher was appointed reader in 1953. The department was founded in 1928 and the Honours school was instituted in the Faculty of Arts in 1930 and in the Faculty of Science in 1934.

1961 University of London, Queen Mary College. The personal title of professor of geography was given to A. E. Smailes in 1955 but his chair of geography was established in 1961. He had been reader since 1953. P. R. Crowe held a readership created in 1947 until 1953. Before 1947 geology and geography were in a combined department under H. G. Smith. Honours courses for the degrees of B.A. and B.Sc. were instituted in 1921.

The University of St. Andrews has lecturers in geography who are head of departments respectively at St. Salvator's College, St. Andrews (Kathleen M. McIver), and at Queen's College, Dundee (S. J. Jones). Honours courses in geography for the degree of M.A. were instituted at St. Salvator's College in 1949 and at Queen's College in 1956, and in the latter College in the Faculty of Social Science in 1961.

This Changing World

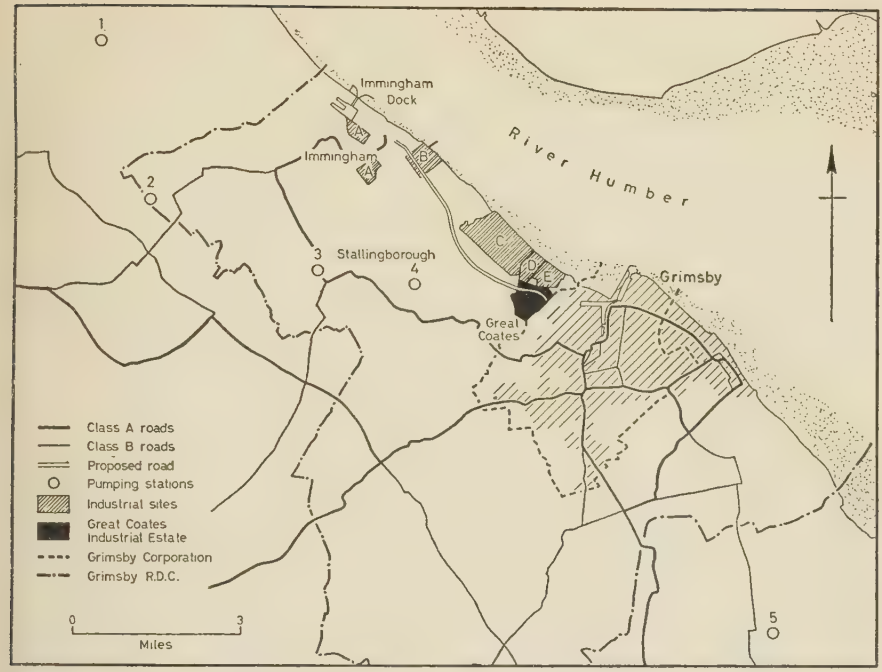
INDUSTRIAL DEVELOPMENT ON SOUTH HUMBERSIDE

In the post-war period there have been some important changes in the economic structure of the Grimsby area: while employment in the fishing industry has fallen considerably there has been a marked growth in the numbers engaged in food processing and curing (especially in the preparation of frozen foods) and in the manufacture of chemicals. This note is particularly concerned with the establishment and expansion of five plants which have been built on south Humberside during the past fifteen years by parent companies that are among the largest operating in the country in the chemical and allied trades. The products of these five plants are all based on chemical processes and give rise to common demands for some essential raw materials: but a number of quite separate markets is supplied and the chemical industry in this area may be regarded as reasonably diversified. The construction of the factories which lie on the Lincolnshire bank of the Humber, between Grimsby and Immingham, has transformed that stretch of the estuary. In June 1961, they employed 4225 people and occupied approximately 1100 acres of land. The buildings and equipment represented a total investment to date of about £35 millions. Development is still taking place on most of the sites so that employment and investment continue to rise.

The choice of south Humberside for the location of these plants was influenced by the combination of advantages offered by the area. These were: (i) adequate land, (ii) adequate supplies of labour, (iii) ample supplies of pure water, (iv) accessibility to the firms' main markets, (v) proximity to the estuary for the disposal of effluent and (vi) generally good facilities for freight transport, especially the deep-water dock at Immingham, which first came into use in 1912. The strength of several of the initial advantages has in some degree been affected by the very development of industry to which they gave rise.

The two principal local authorities have encouraged new enterprise and would like to see the area become a still larger centre of chemical and other specialized and heavy industry. Grimsby C.B. Corporation bought two lots of land amounting to 694 acres in 1946 and 1953, the bulk of which was sold as sites C, D and E on the map. There was no intention of making a profit on these transactions and the Corporation actually suffered a loss as a result of the money it spent on road improvements and the construction of railway sidings to improve the industrial amenities of the land. In 1960 the Corporation purchased a further 189 acres in Great Coates and this land is now being developed as a light industrial estate. Site B was acquired from the Grimsby R.D.C. and site A has been leased by the British Transport Commission. A disadvantage of much of this land, although not a major one, was its marshy nature, which imposed some handicap on site preparation and added to the costs of construction through the need to sink piles.

The Humberside firms have not so far experienced any great difficulty in obtaining the necessary labour, except in a few specialized categories. The majority of their workers comes from Grimsby and the immediate vicinity,



Pumping stations: 1—Thornton; 2—Habrough; 3—Little London; 4—Healing; 5—Tetney.
Factories, showing year in which production started:

	Main products	Main raw materials	and sources
A. Fisons Fertilizers Ltd. (1950)	Single and triple superphosphates	Phosphate rock	Morocco, Florida
	Compound fertilizers	Muriate of potash	Israel, Spain, W. Germany, U.S.S.R.
		Sulphur	Texas, Mexico
		Sulphate of ammonia	Co. Durham
		Ammonium nitrate	Essex
		Coal	Yorkshire
B. Laporte Titanium Ltd. (1953)	Titanium dioxide pigments (rutile and anatase grades)	Ilmenite	Finland, Norway, Malaya, Australia, S. Africa
		Sulphur	Texas, France
		Pyrites	Cyprus
		Coal	Yorkshire
C. Courtaulds Ltd. (1957)	Viscose staple yarn	Wood pulp	S. Africa, Sweden
	Acrylic fibre	Carbon disulphide	Lancashire
		Sulphuric acid	Lancashire
		Caustic soda	Co. Durham
		Acrylonitrile	Co. Durham
D. CIBA Laboratories Ltd. (1951)	A variety of fine chemicals and pharmaceutical products	Bulk acids and alkalis; organic intermediates	Switzerland, Lancashire and Cheshire
E. British Titan Products Co. Ltd. (1949)	Titanium dioxide pigments (rutile grade)	Ilmenite	Kerala, Finland, S. Africa
		Sulphur	Texas
		Pyrites	Cyprus, Sweden, Br. Columbia
		Coal	Yorkshire

and only a small number of senior executives and technical staff has had to be brought in from other parts of the country. Within the Grimsby employment exchange area the total insured population has risen from 51,905 in June 1949 to 60,983 in June 1960, and some kinds of labour, especially female, have become in increasingly short supply. The five Humberside concerns, as well as other firms in the area, have expansion plans and the demand for labour will rise. There is a difference of opinion among businessmen in the locality on the effects of this, some feeling that labour shortages could develop and retard the further growth of industry while others believe that the increasing prosperity of the area will stimulate inward migration and lead to a net increase in the working population. One's impression is that this optimistic view is the more widely held.

The chemical processes employed require large amounts of pure water and the average daily consumption in the five plants is at least 10 million gallons. The water is derived entirely from the chalk: some is pumped from licensed bore-holes operated by the firms, but the bulk is supplied by the North East Lincolnshire Water Board. The map shows the five main pumping stations from which the Board supplies its industrial consumers. The bore-holes that feed these stations have a maximum daily rate of delivery of 12 million gallons, which will be raised to 16 million gallons when works at the Tetney and Thornton stations are completed. Both stations lie outside the Board's area and are worked by arrangement with neighbouring water authorities. The industrial growth of the Grimsby area has had radical effects on the water supply and the present daily consumption of about 30 million gallons is very close to what is thought to be the maximum safe rate of abstraction from the chalk, if the long-term supply position is not to be threatened. Since developments in Grimsby and on the Humber bank will lead to a greater demand for water the North East Lincolnshire Water Board is seeking new sources of supply, of which the most likely to be exploited is the river Trent, if the Minister of Housing and Local Government sanctions the scheme.

Considerable amounts of effluent have to be disposed of and can be discharged directly into the estuary. One firm has an impounding tank, with one day's capacity, and ejects its effluent at high tide, but the others have preferred to pump continuously through pipelines which they have laid into the water below the low-tide level. For the most part the effluent needs no treatment before discharge and this is an economic advantage in itself. Another feature of the chemical industry of Humberside is its very large consumption of sulphuric acid, which in mid-1961 was about 13,000 tons a week. The acid is made almost entirely on site by the two titanium dioxide producers and by Fisons Fertilizers Ltd. Largely as a result of their operations this stretch of the Humber now contains the greatest single concentration of sulphuric acid manufacture in Britain.

Railway and shipping facilities for the firms are good but road transport is hampered by the winding and often narrow character of the most heavily used roads in the area. Grimsby Corporation has tried unavailingly to get the support of the Ministry of Transport in building a direct road between Grimsby and Immingham. This is shown on the map as a proposed road and it would link up at both ends with existing minor road systems. In lieu of the direct road the most that can be expected is the piecemeal improvement

of those class A and B roads which are now carrying the growing industrial traffic.

The story of the docks is very different. It can be said that the growth of the chemical industry has had a marked revivifying and diversifying effect on the docks of both Grimsby and Immingham, but particularly on the latter. Between the wars Immingham relied heavily for its import and export traffic on the coal and iron and steel industries. These are still important users of the docks but large quantities of petroleum and chemical products are now being handled as well. The quays have been re-paved and new cranes installed; efforts are being made to encourage liner traffic also and the Ben Line has made Immingham a port of call for some of its services. The increase in the import traffic at Immingham due to materials used by the Humberside firms is indicated by the table below (figures in tons).

Year	*Phosphate rock*	*Sulphur*	*Pyrites*	*Ilmenite*
1950	78,632	53,234	—	78,632
1955	262,688	55,371	138,494	84,013
1960	326,084	136,887	118,747	310,664

The main chemical products shipped from Immingham are fertilizers and the quantity of these has risen from 391 tons in 1950 to 109,867 tons in 1960. Grimsby docks are used for the importation of most of the wood-pulp, the amount coming there in 1960 being 161,905 tons compared with the 18,660 tons imported through Immingham.

In all it can be said that the establishment of chemical manufacture on a large scale has been the most significant event in the post-war history of the Grimsby area. The new plants discussed here have given a direct and an indirect stimulus to the local economy which has been of especial value to an area that, before the last war, had a rate of unemployment above the national average and which feared at one stage that this state of affairs would obtain again in the post-war period. This fear has not been realized and the explanation of the fact can in large measure be found in the industrial development of the south Humber bank.

University of Hull OWEN S. HINER

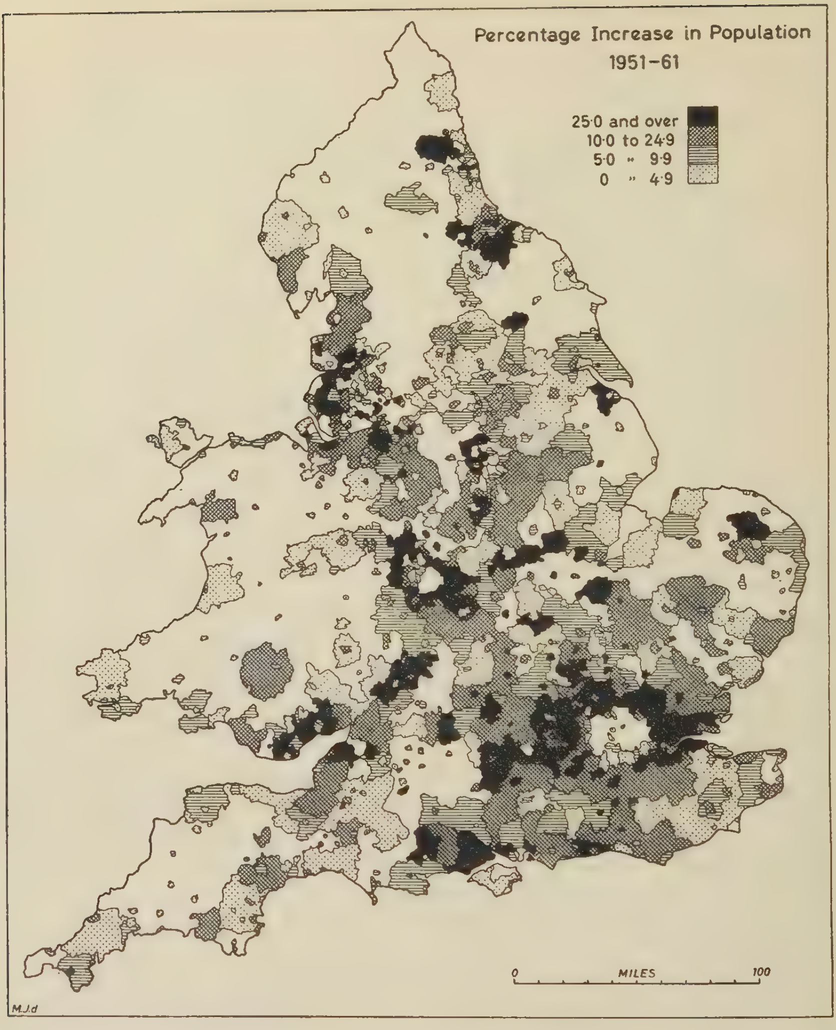
POPULATION CHANGES IN ENGLAND AND WALES 1951–61

The 1961 Census was taken on 23rd April and its findings will be published during the next three years in a series of reports. In due course these will provide information about changes in population distribution and structure in the decade 1951–61. In June a preliminary report was published and from this it is possible to make some assessment of the major changes in population distribution that have taken place. In this period the population of England and Wales rose from 43,757,888 to 46,071,604, an increase of 5·3 per cent. This rate of growth, however, was not uniform throughout the country for population distribution has been changing in three ways.

1. Population in rural areas has continued to decline steadily. This is particularly marked in the north and west of the country.

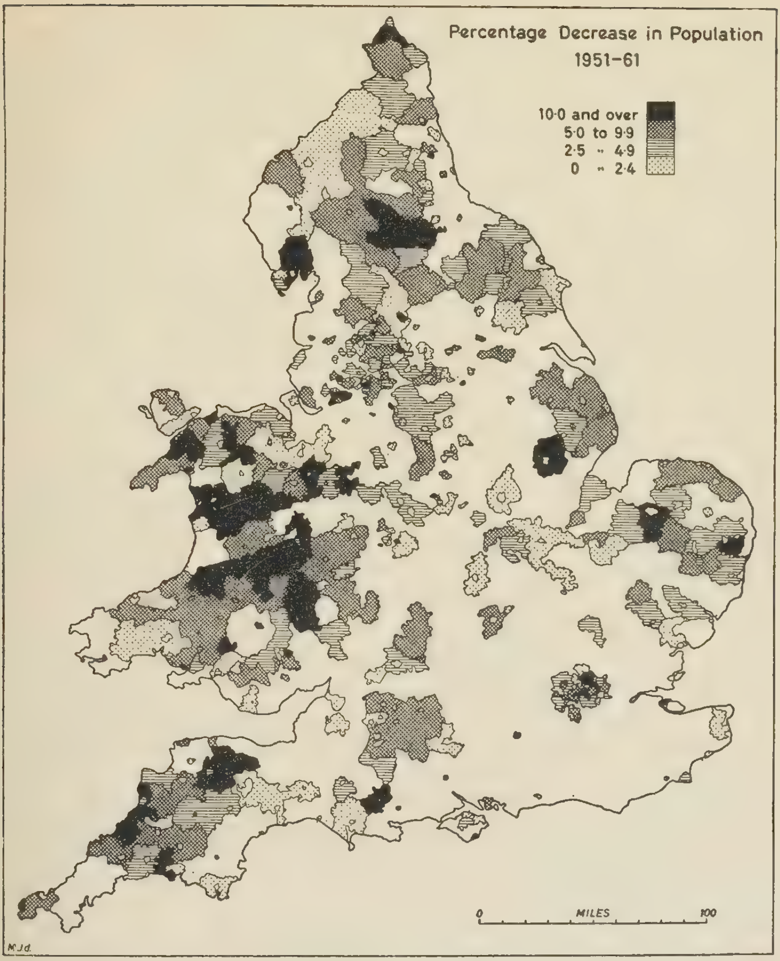
2. The Midlands and southeast England have continued to increase their population at a very high rate.

3. Population has continued to move out of the larger cities and conurbations, mainly to residential areas beyond their boundaries. Until 1951 the



total population of the six census conurbations increased, but since then it has declined.

The most important feature of this period has been the continued high rate of increase in southeast England. Most of the local authorities within the main built-up area of Greater London have declined in population but this central core of decrease is surrounded by a broad zone where population has increased very rapidly. Part of this growth is the result of overspill from within the Greater London conurbation which lost 176,000 or 2·1 per cent of its population in this period. The effect of this is most easily distinguished in the development of the new towns. Essex, Berkshire and West Sussex were all affected while the four new towns in Hertfordshire accounted for nearly one half of the county's 36 per cent increase. No figures can be isolated for unplanned overspill but it has been of undoubted importance and appears to have been little affected by the Green Belt policy. However,



this movement outward from the conurbation accounts for only part of the total increase in this zone: other important factors are the high rate of natural increase in southeast England and migration into the region. The preliminary report provides no detailed breakdown of migration statistics, but some idea of the volume of migration into the southeast can be obtained by using the figures given for standard regions. Migration into the Eastern, Southern, and London and Southeastern standard regions, that is roughly those counties lying to the south and east of a line joining the Wash and the Solent, was more than half a million. Thus, while it is clear that migration into the region is not taking place at the same rate as in the inter-war period, it is still a very important factor.

The areas where rates of increase have been highest lie mainly to the north and west of London where Bedfordshire (22 per cent), Berkshire (24·9 per cent), Buckinghamshire (25·9 per cent) and Hertfordshire (36·5 per cent) had very high rates of growth. At the same time the relatively low rates of increase in Kent (8·7 per cent), Surrey (8·1 per cent) and

Hampshire (11·6 per cent) should not be underestimated; each county added more than 130,000 to its population. The 11·8 per cent increase in Essex represented 242,000 people, by far the largest absolute growth in the country.

Outside southeast England the area of greatest increase has been the Midlands. Northamptonshire (10·7 per cent) and Rutland (16·6 per cent) had the highest increase rates but the most important area of increase lies round the edge of the West Midlands conurbation. This growth, which is due in part to overspill from the conurbation, accounts for the relatively high rates of increase in Worcestershire (8·4 per cent), Warwickshire (8·7 per cent) and Staffordshire (7·1 per cent). Similar, but smaller, areas of growth are found in the East Midlands round Leicester, Nottingham and Derby. As in the southeast, migration into the region has been very important, being more than 100,000 for the East and West Midlands taken together. Thus, the increasing concentration of population and industry into the Midlands and southeast England, criticized in 1940 by the Barlow Commission, continues unchecked.

Beyond this broad area of above-average increase in central and southern England certain areas stand out where population has either relatively or absolutely declined. The most obvious of these are the highland areas of the north of England, Wales and the southwest peninsula. In the north the general pattern is one of rural depopulation and movement into the large industrial areas, while more than 250,000 have left the area north of a line from the Humber to the Mersey. In the northeast, Middlesbrough and Newcastle-upon-Tyne have been the main centres of growth, although only the North Riding of Yorkshire (5·5 per cent) increased its population at a rate above the national average. In the northwest, Lancashire alone appears to have any large areas of increase, but this is principally due to overspill from the older industrial areas, for the population of the county as a whole rose by only 0·3 per cent. This low figure is due in part to loss of population to Cheshire as a result of overspill from the Liverpool and Manchester conurbations.

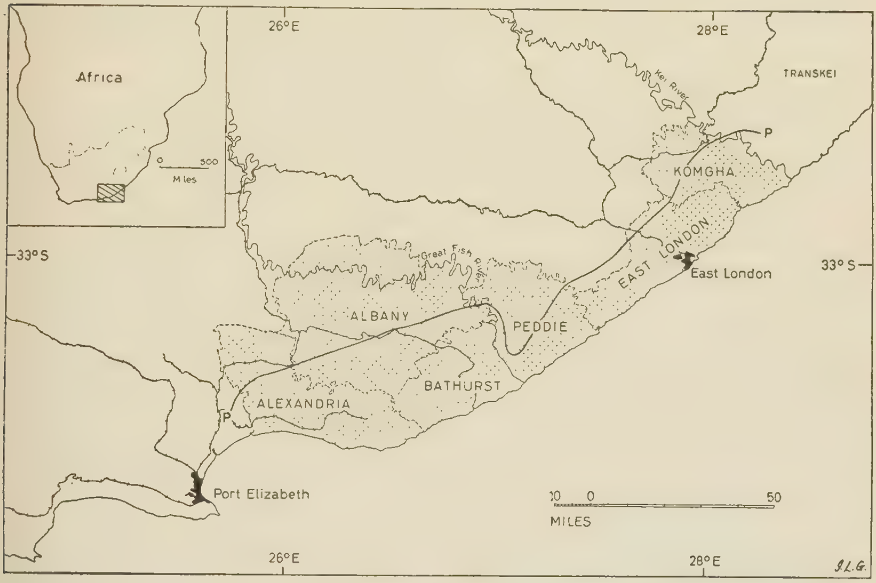
A similar picture is presented by Wales where the relative decline, which began after the First World War, has continued. Losses by migration amount to nearly 50,000 and only in the coastal industrial area round Cardiff and Newport has there been any significant growth. Nevertheless, even Glamorgan (2·1 per cent) and Monmouth (4·4 per cent) show rates of increase that are below the national average. Other large areas of decrease are the north and west of Devon and Cornwall, Salisbury Plain and much of Norfolk.

London School of Economics M. F. Tanner

CHANGES IN THE SOUTH AFRICAN PINEAPPLE INDUSTRY

The recent world slump in pineapple prices has led to changes in the location of South African pineapple production and the related canning industry. South Africa became an important pineapple producer only after 1945; output having increased from 10,000 tons in 1945 to 100,000 tons in the 1957–58 season. The latter figure represented 5·39 per cent of world output, and placed South Africa in seventh position among the pineapple producing countries of the world.

The expansion of the South African industry was induced by high prices caused by a world-wide shortage which was mainly due to the wartime destruction of the Malayan and Formosan pineapple industries, and was based on a large export trade of canned pineapples, primarily to Britain. The high prices reached a peak in the 1953–54 season. Then overproduction in South Africa and Australia and the recovery of the Malayan and Formosan industries started a decline in world prices which reached a climax by 1958–59. The reaction in South Africa was far reaching: pineapple plantings decreased, many farms went out of production and the centre of production shifted.



The line **P—P** marks the approximate inland limit of commercial pineapple production.

The South African pineapple industry is concentrated in a strip 20 miles wide along the coast of the Eastern Cape Province between Algoa Bay in the west and the Kei river in the northeast. In the 1955–56 season 86·5 per cent of the pineapple acreage of South Africa was in six magisterial districts in this belt.

The coastal belt of the Eastern Cape is characteristically a seaward-sloping plain, rising to between 1500 and 2000 feet above sea-level on its inland margins, and dissected to a varying degree by often deeply entrenched, meandering river valleys, the largest of which, the Great Fish, divides the pineapple belt into two and forms a well-defined boundary between the hinterlands of the ports of East London and Port Elizabeth.

The Bathurst and Albany districts were the first to be extensively developed under the impetus of the post-war boom in pineapple prices, and a Government Pineapple Research Station was established at Bathurst. As the boom continued the large-scale plantings were extended east of the Great Fish river, mainly in the East London district. It was soon found that these eastern areas were more favourable for pineapple production, chiefly because

of climatic factors, including a higher rainfall, a longer growing season and less frost and sunburn hazard; soil factors too were significant. A recent sample survey has shown that pineapple yields are considerably higher in the areas east of the Great Fish. Although having a greater concentration of pineapple acreage because of its early start, the western area, centred on Bathurst, thus became generally more marginal in the economic sense.

PINEAPPLE ACREAGE IN THE EASTERN CAPE PROVINCE BY MAGISTERIAL DISTRICT 1955–56

West of Great Fish river	*Acreage*	*Percentage of S. African total pineapple acreage*
Albany	10,901	18·3
Alexandria	4,834	8·1
Bathurst	16,535	27·7
East of Great Fish river		
Peddie	4,876	8·2
East London ..	12,207	20·3
Komgha	2,205	3·7
Total	51,558	86·5

When pineapple prices began to fall the area west of the Great Fish river was most affected. Farms in these districts were generally the first to curtail plantings and the first to go out of production. Since 1955–56 the rate of planting has been higher in the eastern districts and their increasing importance was emphasized by the recent move of the Government Research Station from Bathurst to Collondale in the East London district.

In recent years about 90 per cent of South African pineapples have been canned, mainly for export. The first cannery, established at Port Elizabeth on the western edge of the pineapple belt as long ago as 1919, was until 1948 of minor importance. That year, in response to the early expansion of pineapple farming in Bathurst and Albany districts, the cannery was extended and another brought into production in the city, followed by a smaller one in 1949. To supply these a can-making factory was opened. During the early 1950s the Port Elizabeth canners served the whole of the pineapple belt, the fruit being railed to the city at the canners' expense. In these years Port Elizabeth was the best location for pineapple canning in South Africa, being the sea-port nearest the main producing areas.

When pineapple production expanded in the East London district canneries were established in that area to avoid the long rail haul to Port Elizabeth and the high freight charges on a sensitive fruit with a high waste ratio. The first large pineapple cannery in the East London area was opened in 1956. Within the next two seasons the two largest canners in Port Elizabeth curtailed expansion there and set up large branch factories in East London. During the 1958–59 season four factories processed 60,000 tons of pineapples at Port Elizabeth and five 51,000 tons at East London. In 1960 the shift of the industry to East London was carried further by the decision of one of the two large Port Elizabeth canners to stop processing pineapples there and to concentrate all activities at their East London factory, even though this firm owns a large pineapple farm in the Alexandria district within 35 miles of Port Elizabeth.

It is estimated that during the 1960–61 season 42,000 tons of pineapples were processed at Port Elizabeth and 70,000 tons at East London, clearly showing the ascendancy of the latter as a canning centre and a trend likely to continue. A probable consequence is that the can-making factory which supplies both centres will be moved from Port Elizabeth to East London. In terms of employment, since 1956, about 2500 mainly seasonal jobs have been created in the East London area, whilst over the same period similar labour has been laid off in Port Elizabeth. The whole is a small example of changing location in an industry which is closely tied to its raw material source.

London School of Economics I. L. Griffiths
(*formerly of Rhodes University, Port Elizabeth*)

THE SOUTH AFRICAN FERTILIZER INDUSTRY

It is well known that yields from cereals in South Africa are poor, and that extensive farming in both arable and pastoral spheres has always been the general order of affairs. There are of course reasons for both the poverty of yields and the extensive farming: the former is largely due to poor soils and difficult climatic conditions, while the latter is a combination of a traditional attitude towards farming and the need for large areas as a result of poor yields. Experiments carried out at the Potchefstroom School of Agriculture and at the Vaal Hartz Research Station have shown that a vast improvement can be made in the yields of cereals with the increased and intelligent use of fertilizers. Increased yields and the possibility of more intensive agriculture are extremely attractive developments in a country where only about 5 per cent of the total area is under crops.

The need for fertilizers in South African agriculture in general has been realized for many years but until recently their high cost has deterred their widespread use. For many years all fertilizer had to be imported from Europe, until the conversion, before 1939, of two former explosive factories—Somerset West near Cape Town and Umbogintwini on the southern outskirts of Durban—to the production of superphosphates. Since 1959, however, vast strides have been made in the production of fertilizers within South Africa, and current developments will make the country self-sufficient in their production. At the beginning of 1959 a £1½ million extension to the plant at Umbogintwini was opened by African Explosive and Chemical Industries Ltd., which will increase the plant's annual production of superphosphates to 600,000 tons and of mixed fertilizers to 250,000 tons. Production at the Phosphate Development Corporation (FOSCOR) factory at Phalaborwa (some 100 miles east of Pietersburg in northeast Transvaal) is also to be increased.

1959 also saw the opening of a new £2½ million factory at Sasolburg in the northern Orange Free State. At this factory up to 200,000 tons of superphosphate and 112,000 tons of granulated compound fertilizer will be produced annually.

An important plant for the production of ammonium fertilizers exists at Modderfontein in the Transvaal. In 1957 it was decided to increase the output of this plant to 145,000 tons per year. The operation of this enlarged factory will be based on low-grade non-coking coal from Transvaal instead

of the valuable metallurgical coal previously in use and which in future will be diverted to essential purposes in the expanding steel industry. The most important development in the South African fertilizer industry, however, also took place in Modderfontein in April 1960, when a new £10 million plant started to produce a fertilizer which it is claimed is ideally suited to the needs of South African farming. By 1963 there will come annually from this plant 110,000 tons of urea—a fertilizer which contains 40 per cent nitrogen and which has the advantage of being usable in either a solid or liquid form. It has other advantages too in that it is more easily absorbed by plants than superphosphates and controlled amounts can be fed to cattle, sheep and goats to make up for deficiencies which stem from a carbohydrate diet low in protein—a feature common in South African animal husbandry.

The increased production of fertilizers has wider implications than the enormously important effect it will have on South African farming. It is intended that export of various fertilizers should be undertaken to the Federation of Rhodesia and Nyasaland and the territories of East Africa, areas where fertilizers are greatly needed and where local production is very low. (A new factory using power from Kariba has been established outside Salisbury in Southern Rhodesia and plans exist for a £9 million nitrogenous fertilizer plant in the same locality, while there is also a limited phosphate production in Uganda based on apatite from the Tororo deposits, and in Kenya at Torbo.) The situation of the fertilizer plants within South Africa means that their products can be sent to the northern countries very easily by ship or rail.

The production of urea, which will meet all the requirements of South Africa, the Federation and the East African territories, also has other implications. Certain grades of urea can be used in the manufacture of synthetic products for plastic moulding and adhesives, in the production of detergents and cosmetics, and for the treatment of textiles, woods and metals. In a country which is apprehensive about conditions when gold output falls, the benefit that urea production will confer upon agriculture and industry must have an important effect upon the continued stability of the nation's economy.

University of St. Andrews G. Whittington

DECENTRALIZATION AND RE-ORIENTATION IN THE AUSTRALIAN IRON AND STEEL INDUSTRY

The commissioning on 23rd November, 1960, of a new basic open-hearth furnace at Port Kembla raised Australia's steel-making capacity to approximately 4,000,000 ingot tons per annum, brought to a climax a decade of investment and decentralization within the steel industry, and inaugurated an era of development based on new techniques, new raw material sources, and new locations for steel plants. Much of the developmental work has been undertaken with the assistance of State Governments.

NEW SOUTH WALES

Port Kembla

Port Kembla, with an annual output of 2·6 million tons of steel ingots per annum, has superseded Newcastle as Australia's largest steel producer, and

has become the second largest steel producer in the British Commonwealth. In the years following the second World War, the annual steel output at Port Kembla was less than half a million tons; the present situation has been achieved only by the expenditure of more than £A100 million on plant and harbour facilities.

Coal and Steel Production at Port Kembla 1947–59

	Ingot Steel (tons)	*Coal Produced (tons)*	*Employees*
1947	478,140	719,201	5,005
1950	631,999	1,021,175	6,447
1954	1,115,689	1,215,628	9,395
1958	1,800,589	1,690,904	13,395
1959	1,883,000	1,708,000	not available
1960	2,162,000	1,754,000	not available

Immediate post-war developments at Port Kembla aimed at expanding and modifying the No. 1 steel plant and coke ovens to provide iron and steel for utilization in the proposed "Flat Products" division. The "Flat Products" era commenced in February 1954 with the manufacture of steel plates in a "hot roughing mill". The first hot strip steel was produced in May 1955. Most of the mills constructed in this period were located on or near reclaimed land in the vicinity of Tom Thumb lagoon. In addition to the construction of processing mills, auxiliary services such as engineering, gasholders, fuel distribution, and locomotives and rolling stock were overhauled and supplemented. The climax of this era came in August 1957 when Australia's first tinplate was produced—the tinplating mill having been constructed at a cost of £A7·7 million.

The foundations for the third "stage" of Port Kembla's development were laid in 1954 and 1955 when it was decided to build a new integrated steelworks (called the Number 2 Steelworks) and to expand existing harbour facilities. The former project was to be built on land reclaimed from Tom Thumb lagoon, and its primary aim was to provide more raw steel for the rapidly expanding flat products division. The new works were planned in conjunction with the "inner harbour" development scheme, a harbour-enlargement project begun in 1954 under the joint auspices of Broken Hill Proprietary Co. Ltd. (B.H.P.) and the N.S.W. State Government (see *Geography*, vol. xlvi, July 1961, pp. 247–50). To supply the new works, extensive ore storage bins and a new ore bridge had to be constructed. The "inner harbour" can provide safe anchorage for up to thirty-seven ships, and has 3000 feet of wharfage designed specifically for ore and steel handling. The State Government agreed to provide an initial capital of £A3·2 million as its share of construction expenses—the total cost is now estimated at £A5 million. B.H.P. designed the wharf to their own specifications. The harbour was officially opened on 28th November, 1960, the first ship entering its precincts being the *Iron Yampi*—with 10,906 tons of iron ore from Yampi Sound, Western Australia.

A recent development at Port Kembla has been the installation of a battery of 96 coke ovens, requiring two and a half million tons of washed coal per year. A new Sendzimer cold-rolling mill (for stainless steel sheet and strip) has an initial output of 10,000 tons of rolled steel per annum (sufficient for Australia's demand). A proposed electrolytic tinplate plant will increase

Port Kembla's tinplating capacity to 118,000 tons per annum, and save Australia more than £A10 million on tinplate imports.

Newcastle

As opposed to the spectacular advance of the steel industry in Port Kembla, developments at Newcastle over the past three to four years have been restricted to improving production techniques, enlarging the existing productive capacity of mills, and planning the reclamation and utilization of Platt's Channel for a high-speed rod mill. Successful attempts have been made to reduce the ash content in coke, resulting in better feed for the blast furnaces and consequently production of better iron.

SOUTH AUSTRALIA

Perhaps the most significant development (for South Australia) in iron and steel technology has been the completion of a process to obtain a high return of ore from jaspilite. The jaspilite deposits at Iron Monarch can now be effectively reduced in a blast furnace, and with B.H.P. prepared to invest £A41 million in building a basic oxygen steel-making plant at Whyalla, South Australia may soon be producing many times her present output of 200,000 tons of pig iron per annum. Extensions to the existing blast furnace began in February 1960, and to serve the altered furnace, the steel wharf has been lengthened by 470 feet to 1300 feet, so that three 12,500 ton ships can berth simultaneously.

The considerable interest taken in the Whyalla–Middleback Range area by both B.H.P. and the South Australian Government may mean that the present investments constitute only the first phase of considerable undertakings. Allied with developments in the manufacture of steel has been the alteration of ship-building facilities at Whyalla to cater for the building of 20,000–40,000 ton ships (doubling the existing capacity).

The more effective utilization of coal and coke by means of oxygen-blowing in the blast furnaces may reduce the locational attraction of coal and hasten B.H.P.'s "decentralizing" programme, particularly in regard to South and Western Australia.

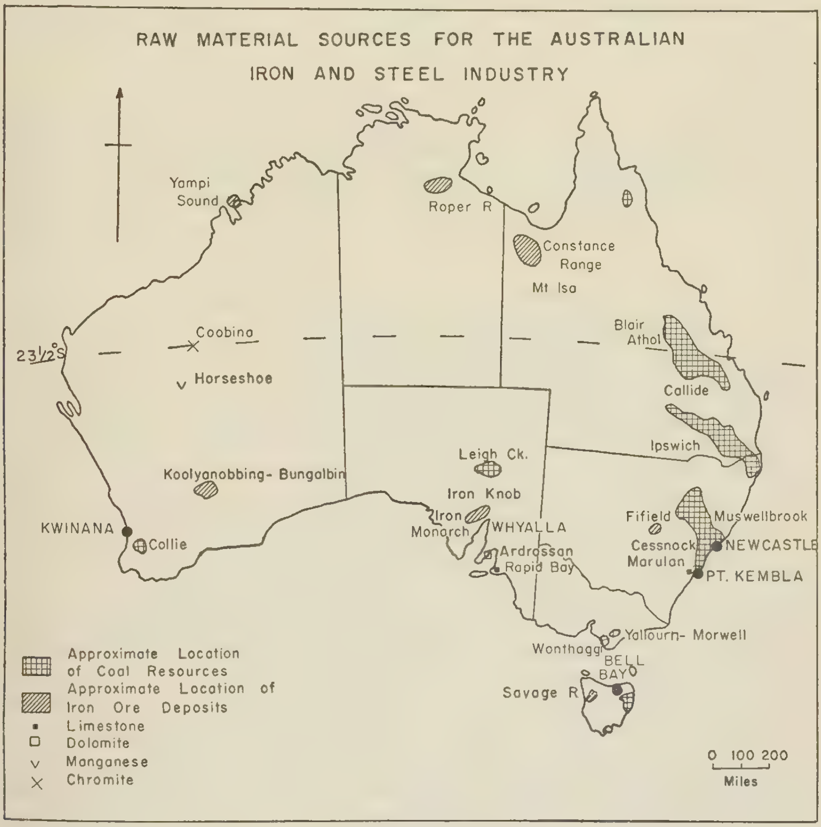
WESTERN AUSTRALIA

The most ambitious undertaking within the Australian iron and steel industry depends upon the Western Australian State Government successfully negotiating with the Federal Government for financial assistance in order to provide a standard-gauge rail-line from Kalgoorlie to Fremantle and Kwinana (12 miles south of Fremantle). A £A40 million integrated iron and steel plant capable of producing 450,000 tons of iron and 330,000 tons of rolled steel per annum is projected at Kwinana, an undertaking encouraged by Western Australia as an attempt to reduce the unfavourable trade balance between the western and eastern Australian states. The total expenditure involved in establishing the iron and steel works, providing wharves and ancillary features, and opening up the ore fields, is expected to surpass £A80 million—all to be spent within the next eighteen years.

The impetus for the development of a Western Australian iron and steel industry originated with the discovery of approximately 100,000,000 tons of high-grade iron-ore reserves in the Koolyanobbing–Dowd's Hill–Bungalbin area, 313 miles from Kwinana. At present the ore is relatively inaccessible

because of a lack of suitable transport, but the State Government is prepared to construct a standard-gauge line from the ore fields to the Kalgoorlie–Perth line, if the Commonwealth will assist in standardizing the Kalgoorlie–Kwinana section (at present 3 feet 6 inches gauge). Both the State Government and the B.H.P. Company claim that "only by greater efficiency—by means of an efficient railway from the ore fields to Kwinana—can the economies of steel production be satisfied". If an agreement is reached, B.H.P. will guarantee to use the railway for not less than 30 years beginning from the commencement of production at Kwinana.

In addition to the Koolyanobbing ore proposals, B.H.P. has begun mining ore at Koolan Island in Yampi Sound: ore from Koolan will be used in eastern Australia.



OTHER STATES

To encourage the discovery and utilization of iron ore in the other states of Australia, the Commonwealth Government has lifted the 1938 embargo on the export of iron ore from all ore fields except Yampi Sound, the Middleback Ranges and Koolyanobbing. This means that the Savage river (Tasmania) magnetite deposits (estimated at 180 million tons) may be developed as an export ore field, and that the recent discoveries at Constance Range (Queensland), and the Roper river (Northern Territory), may also find markets of sufficient magnitude to warrant their development.

The combined attraction of cheap hydro-electricity and a deep-water wharf frontage with installed bulk-handling facilities at Bell Bay (Tasmania) has encouraged B.H.P. to begin construction of an electro-metallurgical industry alongside the aluminium plant already established there. This new plant will manufacture ferro-alloys required in the production of steel, the initial installation being a £A1·66 million blast furnace for ferro-manganese production. The plant will require 100,000 tons of raw materials annually, and will supplement the existing Newcastle plant in supplying the Australian market.

The current position within the Australian iron and steel industry can be summarized by saying "B.H.P. is on the move." The industry now has over 35,000 employees and has been largely responsible for the sound position of Australian manufacturing. In addition to the vast deposits of raw materials already being worked in N.S.W., South Australia and Yampi Sound, even greater—and as yet unworked—ore deposits in Western Australia, Tasmania and Queensland may shortly be exploited.

The dynamic policy pursued by B.H.P. over the last decade has resulted in a re-orientation of the steel industry away from its former node, Newcastle, and the policies set down for future expansion show clearly that the decentralizing process of the post-war period will be continued.

University of Canterbury R. G. Golledge

TAHITI'S RECENT TOURIST DEVELOPMENT

From being a secluded Pacific island, remote and difficult of access, Tahiti is rapidly becoming a centre of tourism in the South Pacific. This new phase is an outgrowth of the inclusion, since 1957, of Tahiti on the itinerary of American tourist liners crossing the Pacific between the U.S. West Coast and Australia, and it has received a further fillip from the opening of an airport in November 1960, capable of handling the world's largest jet airliners, thus making it possible to include Tahiti on regular weekly trans-Pacific schedules. Official statistics quote a total of 705 tourists as visitors to Tahiti in 1955, but by 1959 this figure had grown to 12,000, the majority being ships' passengers. The maximum potential of air tourists is about 15,000 per year under existing schedules, but planning in the tourist industry is based on an expected 130,000 tourists per year by 1965.

Important factors underlying the popularity of the island are its all-seasonal warm sunny climate, its strikingly youthful mountainous interior with peaks rising to 7000 feet and the carefree living of the native Polynesians. Added to this is its centrality to other islands in the Society group which have similar appeal enhanced by less commercial influence, and easily accessible by flying boats or island motor cruisers.

Two major problems face the local government in developing this potentially important segment of the economy. The first is to ensure sufficient facilities for the tourist. At present, for example, there are little more than 200 hotel bedrooms available on the island. Secondly, there is the need to plan against a rash of commercialism that could quite easily sweep away much of the charm and beauty of the islands. Positive steps are being taken to handle these problems under a formal planning scheme introduced by the *Société d'Equipement de la Polynésie Française* and based on a critical standard of economic research into the bases of tourism.

University of Sydney Terence W. Beed

The Geographical Association

THE LATE MR. W. VAUGHAN LEWIS

It is with deep regret and profound sorrow that we record the death of Mr. W. Vaughan Lewis, Fellow of Trinity College, Cambridge, in a road accident in the U.S.A. on 8th June last. An obituary will be published later.

NOMINATION OF MEMBERS OF COUNCIL

Four new members of Council are due to be elected at the Annual General Meeting to be held on 4th January, 1962, to replace retiring members. Nominations, signed by four Full members of the Association, should reach the Honorary Secretary before 15th December. The members so nominated must have expressed their willingness to serve on Council from 1962 to 1964.

ANNUAL CONFERENCE

The Annual Conference will be held at the London School of Economics from 2nd to 5th January, 1962. The programme is in course of circulation to all members. Applications for tickets for excursions, the Annual Dinner etc. and the booking of accommodation at Campbell Hall should be made as soon as possible in accordance with the instructions in the programme.

SUMMER SCHOOL 1961

We record warm thanks to Mr. T. H. Elkins and Dr. E. M. Yates for the excellent and very successful summer school which they directed in Germany during August this year. The field studies covered two contrasted areas—the industrial and rural landscapes of the Ruhr and Berg, and the diverse landscapes of Württemberg, reached from Tübingen. The latter centre is a new area of study for an Association field course and offers excellent opportunities for work in different types of terrain.

SUMMER SCHOOL 1962—NORWAY

We are glad to inform members that the long-awaited summer school in Norway, under the expert direction of our distinguished friend, Professor Axel Sömme, will take place during August 1962. As the number of places on this three-week course will be strictly limited, early application should be made. Details of the course are being circulated to all members.

SPRING CONFERENCE 1962

This conference will be a study course of the area around Keele, Staffordshire, including the Potteries and parts of Staffordshire and Cheshire, under the direction of Professor S. H. Beaver. The conference will be residential at the University College of North Staffordshire from 14th to 18th April, 1962. Programmes and application forms will be issued to members in January.

LAND USE MAPS

Members may be interested to know that six sheets of the Land Use Survey directed by Miss Alice Coleman are now published and can be obtained from Edward Stanford Ltd., 12 Longacre, London W.C.2, price 15s. each, postage extra. The sheets are: no 499, Crowland Fens; no. 264, Princes Risborough; no. 192, Isle of Thanet; no. 174, Deal; no. 481, Downham Market; no. 454, Nuneaton. Orders should be placed direct with the agents, Messrs. Stanford.

CORRECTIONS

In Fig. 3 on p. 62 of *Geography*, January 1961, the scale of "50 or more" in the key, instead of being white, should be in solid black.

The price of *Manual of Photographic Interpretation*, reviewed on p. 177 of *Geography*, April 1961, is $12.00 to members of the American Society of Photogrammetry, and $15.00 to non-members.

WEATHER STUDY IN SCHOOLS

To stimulate interest in meteorology and climatology, the editors of *Weather* have started a Schools' Supplement in that monthly journal, whose subject matter will cover topics in geography syllabuses for secondary schools. The first supplement (October 1961) has articles on atmospheric pressure and hurricanes. Further information is published in an advertisement elsewhere in these pages.

ORDNANCE SURVEY MAPS

With the publication in August 1961 of the last six sheets of the Seventh Series, the whole of Great Britain has been covered for the first time in the history of the country by a single series of maps at the one-inch scale in which all sheets are similar in size and style. The series of 190 sheets has been produced during the years 1952–61. Revised sheets in the series have already been published, incorporating major road changes; all maps now carry the latest information on major roads whenever they are reprinted. In future reprints a change will gradually be introduced—using six instead of ten colours for this series—though with little appreciable difference in the style of the maps. The colours to be introduced will be black (base detail, grid, vegetation (screened), house fillings (screened)); blue (water, water names, submarine contours, sea tint (screened)); brown (contours, 2nd class roads); red (1st class roads); yellow (unclassified roads); and green (woods).

BOOKS AND SLIDE MOUNTS

A useful classified list of geography books, for fifth- and sixth-form work, has been published by Dillon's University Bookshop Ltd. The inclusion of dates of publication and prices makes the catalogue useful for teachers selecting titles for school libraries. Messrs. Dillon, who will supply the books listed, advertise the catalogue elsewhere in these pages.

Individual pictures cut from most film-strips (single-frame size: 24 mm. × 18 mm.) require cardboard mounts with small apertures. These can be got from Diana Wyllie Limited, 3 Park Road, Baker Street, London N.W.1, at 2s. 3d. for 15 or 13s. 6d. for 100 (postage included). The more common double-frame size mount can also be purchased there. The smaller size is especially useful for making up sets of slides from film-strips.

LIBRARY BOOKS APPEAL

The Association's library is urgently in need of the following books, some of which are out of print. We shall indeed be grateful to members who can donate copies to the Association:

P. W. Bryan, *Man's Adaptation of Nature* (Univ. London Press)
W. G. East, *Mediterranean Problems* (Nelson)
O. D. von Engeln, *Geomorphology* (Macmillan Company)
R. F. Flint, *Glacial and Pleistocene Geology* (Chapman and Hall)
A. K. Lobeck, *Geomorphology*
L. J. Wills, *The Physiographic Evolution of Britain* (Arnold)
A. C. Trueman, *The Coalfields of Great Britain* (Arnold)
20th Century Fund, *World Population and Production. Trends and Outlook*
P.E.P., *World Population and Food Resources*

Atlas of Australian Resources

A Review

The publication of five more sheets of the *Atlas of Australian Resources** in 1960 completed the series begun in 1951. The decision to publish the atlas serially was undoubtedly sound, as it has meant that many of the more important maps have been available for several years, and have not been held back until the entire atlas was ready, though, inevitably, some of the earlier maps are now rather dated. To teachers in Britain, the atlas represents an important source of geographical information about Australia. To many who would find it hard to justify the purchase of the entire atlas out of a limited budget, the availability of individual sheets, with their accompanying commentaries, is undoubtedly a most welcome feature. The teacher who has to limit his purchase to half a dozen sheets will probably prefer to select those that offer something new, but relevant to the major topics that *must* be treated in the limited time he can spare for the geography of Australia. The main purpose of this review is to indicate maps that deserve a high place on any such priority list.

The map of Dominant Land Use makes a strong claim for pride of place on our short list. Thirteen categories of Land Use are shown, including the built-up areas of the major cities and the areas of no significant use. No attempt is made to show the use of land for mining or industrial purposes, as neither would "dominate" areas large enough to warrant inclusion at a scale of 94·7 miles to the inch. As it is, some of the small patches of purple, indicating the growing of fruit, vines, vegetables, flax, tobacco, cotton, rice or peanuts, have had to be drawn rather larger than the acreages involved would seem to justify. Nevertheless, the very limited extent of orchards and vineyards in the Murray valley may come as a surprise to many; a comparison of this map with that showing the Conservation of Surface Water is most instructive. On the other hand, the bold colouring used for the beef cattle areas of the north and centre gives an impression of intensity that may mislead the unwary. Mr. A. J. Rose's commentary should prove useful to teachers, though they will look in vain for any account of how the map was compiled. This shortcoming is shared, unfortunately, by almost all the commentaries, which concentrate on what each map shows and refrain from discussing the cartographic problems involved.

To amplify the treatment of Australian agriculture, there is a choice of three maps, entitled Distribution of Stock, Agricultural Production and Croplands. The Stock map fails to give a clear picture because it tries to do too much, using three sets of coloured dots (for sheep, beef cattle and dairy cattle) on a background of eight different shades representing pasture types. Beneath all this is the standard base plate, in a very light brown, showing rivers, railways, place-names, etc., and boldly over everything run the 10, 20 and 30 inch isohyets, in puce, and pecked black lines marking the stock routes to the railheads or meatworks. All this information would have been more easily studied on four maps of half the scale, the format used for the Croplands sheet. While some of the supplementary data are new, dot maps of livestock have been published from time to time in the *Commonwealth Year Book*. Incidentally, no attempt is made to justify the equating of one cow with ten sheep, implicit in the use of the same size of dot for 2000 cattle and 20,000 sheep.

* *Atlas of Australian Resources*. Dept. of National Development, Canberra. Distributed in the United Kingdom by Angus and Robertson Ltd. 30 map sheets ($29\frac{1}{2} \times 28\frac{1}{2}$ in. 25 sheets at 1 : 6,000,000; 5 with several smaller-scale maps) and commentaries. Individual sheets folded or unfolded, with commentary, 10s. 6d. each; with linen strip, single folded for looseleaf binding, 12s. 6d. each. Boxes for folded sheets (10 per box), 10s. 6d. each. Published 1951–60.

Ratios of 1 : 5 or 1 : 7 are usually thought to give a better idea of comparative carrying capacities than a 1 : 10 ratio.

The map of Agricultural Production gives a vivid portrayal of the contrast between "Agricultural Australia" and "Empty Australia". It colours green all local government areas having one acre or more in every thousand under cultivation, but even this broad definition excludes all areas over 300 miles from the coast, in New South Wales and Victoria, while the "uncultivated" areas come right to the sea in two places in central Queensland. Superimposed on the green tints are pie-graphs showing the average value of production of the major crops in each statistical division for 1945–51. These symbols give only a general indication of the location of each type of production, whereas the recently published Croplands sheet, using a variety of small coloured symbols, manages to locate production reasonably accurately, despite the smaller scale of its maps. Its two maps dealing with wheat production not only locate the wheat belt, but show changes in average acreage from 1948–51 to 1953–56, and changes in average yield between 1934–39 and 1951–56. The reasons for these trends are discussed in Dr. R. K. Wilson's excellent commentary.

Turning to mining and manufacturing, I should put the maps entitled Mineral Industry and Manufacturing high on our list. Both are among the most recently published sheets, and are accompanied by very good commentaries. The Mineral Industry map, showing production in 1956, is preferable to the earlier map of Mineral Deposits, which is mainly remarkable for its cartographic ingenuity in representing no fewer than 71 different minerals. Many of the deposits marked are no longer worked. The newer map shows current workings, the movement of minerals, and the location of smelters and refineries. The Manufacturing sheet contains nine maps, on three different scales. The largest, in the centre, shows employment in manufacturing, using the 1954 census data, while the eight smaller maps deal with the major groups of factory industries, as they were in 1958, and cover in all some 87 types of manufacturing.

On the transport side, the new map of Ports and Shipping is of considerable interest, and its commentary contains material not readily available elsewhere. The map shows the hinterlands from which the ports draw their exports. The map of Roads and Aerodromes can be recommended for its picture of the division of Australia into "roaded" and "roadless" parts, even though only the major roads are shown. It ties in well with the map of Population Distribution and Density, which also deserves a place on our lists, even though it was drawn from the 1947 census data. The scale of the map and the sparseness of settlement made it impracticable to show the rural population by dots, so that a choropleth system was used. The urban population is shown by grey spheres for centres with over 1000 people, and small brown discs for townships with 250–999. Unfortunately, no attempt has been made to distinguish between the very sparsely settled areas (under 1 person to four square miles) and the completely uninhabited tracts. Perhaps the most striking feature of the map is the very small number of towns, about two dozen, in the low-density areas. Several of them are mining centres and all but two are on a railway. This paucity of urban centres in the "outback" is seen again in the maps showing schools and hospitals.

The Immigration sheet will repay careful study. It uses the four-map format to show where the immigrants of the period 1947–54 were living in 1954, and the contribution they made to rural and urban growth in that period. The distribution of the aboriginal population, unfortunately, is not depicted in the *Atlas*.

Maps of features of the physical geography of Australia make up one-third of the *Atlas*, but have not been placed near the top of our list because small-scale maps of the same topics are readily available elsewhere.* However, the publication of

* E.g., in *The Australian Environment* (C.S.I.R.O.) reviewed elsewhere in this issue, and in the *Commonwealth Year Book*.

a geological map in the last set of Atlas sheets will be welcomed by many, despite its complexity and its inconsistency in showing unconsolidated Quaternary deposits in the eastern states but only the "solid" in Western Australia. The commentary contains a useful sketch map of the "elements" of Australia's geology. As a relief map, the Physical Features sheet is quite attractive, with two useful innovations: it hints at, rather than defines, the area of sand-ridge desert, and it distinguishes between streams with a permanent flow and those streams, or parts of streams, that flow only seasonally. The latter feature is also incorporated into the maps of Drainage and Conservation of Surface Water.

It would be a great pity if the Department of National Development, having completed, in a modified form, what it set out to do, were now to lose interest in its *Atlas*. Much remains to be done, even to complete the mapping of resources, while many of the maps already published will require bringing up to date from time to time, e.g., after each census. Furthermore, this could form the nucleus of a National Atlas of which Australians might well be proud.

J. S. Duncan

Reviews of Books and Atlases

With very rare exceptions books reviewed in this journal may be borrowed from the Library by full members and student library members of the Association.

Geographical Essays in memory of Alan G. Ogilvie. R. Miller and J. Wreford Watson (eds.). 15 × 22·5 cm. xvi + 246 pp. Edinburgh: Thomas Nelson & Sons. 1959. 42s.

For the late Professor Ogilvie geography was rooted in the realities found in the landscape, in the study of regions as they are. The thoroughness of his scholarship led directly to an appreciation of the need to recognize the influences of the past, both physical and historic, for full understanding of regions today and he wished to see significant research in all fields of geography contribute to the study of regional geography. Had Ogilvie lived to have as a *Festschrift* what is now a memorial volume he would have been highly gratified to find in this valuable addition to geographical literature impressive evidence of the effectiveness of his influence and enthusiasms on both pupils and colleagues. Here are geographers, who have been with Ogilvie, at work on the kinds of geography or in the geographical regions that interested him and all making first-class original contributions. Appreciations of A. G. Ogilvie as a teacher and university figure by the editors and of his place in British geography by J. N. L. Baker are followed by five essays on Scotland. Professor R. Miller examines the elements that have gone to make up the strong personality of Orkney. Professor D. L. Linton's essay on "Morphological Contrasts of Eastern and Western Scotland" makes a fundamental advance in our understanding of Scottish geomorphology and contributes splendidly to that remedying of "our ignorance of Scotland" for which Ogilvie appealed. T. W. Freeman compares the two physically similar environments of southwest Scotland and northeast England and traces in their differing economic and political histories the explanations for their marked differences in landscape. A. Macpherson discusses "Land Use Problems in the Hill Areas of Scotland" and K. Walton's closely reasoned essay on "Ancient Elements in the Coastline of Northeast Scotland" suggests that the majority of the cliff features precede the earliest of the ice sheets.

The second part of the volume contains essays on oversea themes. Professor J. W. Watson illustrates from Halifax, Nova Scotia, the value of relict geography in

advancing an appreciation of the essentially dynamic quality of city morphology. J. K. Wright in "Some British 'Grandfathers' of American Geography" pays tribute to Ogilvie's contribution to the advancement of the study of geography in the U.S.A. by a review of British influences upon the writing of regional geography in the United States in the late eighteenth and early nineteenth centuries. J. M. Houston in an essay on "Land Use and Society in the Plain of Valencia" evokes a picture of the complex personality of the region with a vividness that would have delighted his professor who first encouraged the research. A. T. A. Learmonth examines some aspects of human health in communities in close contact with tropical forests and Lady Agnew in "South African Farming and the Pioneer Legacy" argues that the backwardness of South African agriculture and the present land deterioration are to be explained, over and above the physical handicaps, by the fact that two semi-nomadic peoples, the Boers and the Bantu, have been forced from pastoralism into the complexities of sedentary agriculture which is alien to their tradition. It is pleasing to think that the abiding value of these essays will make this volume an enduring commemoration of Professor Ogilvie.

N. P.

The British Isles. A Systematic and Regional Geography. G. H. Dury. 14·5 × 22 cm. xiv + 503 pp. London: Heinemann Ltd. 1961. 30s.

Seldom, if ever, can so much information on the geography of the British Isles have been incorporated in a volume of similar size. Furthermore, this information is most competently presented and a genuine attempt has been made to be as up to date as possible and particular attention is paid to the changes that have taken place since the War. Nuclear power, the planning of new towns, the mechanization of agriculture, nationalization and changes in overseas trade have all been discussed in their geographical context. On the other hand, more with advantage could have been said about the increasing significance of artificial fibres in the country's textile industry and of the growth of oil refining and its influence on the chemical industry.

Just over one-third of the book is devoted to a systematic account of the physical geography, land use, industry and trade and communications of the British Isles, culminating in a study of the population with particular reference to urban geography. The remaining two-thirds is a regional study in which the typical quality of a region as a whole, and its differences from adjacent regions, are determined largely by means of physique, climate and agriculture. Individual regions, however, are delimited by reference to economy and population, and, since they derive their unity neither from physique nor from land use, are superimposed on regions bounded by physical and agricultural limits. This method leads in some instances, and particularly in the north of England, to difficulty in following a truly regional approach, but any criticism on this score is compensated by the clarity of description at what the author admits to be a double-tiered level. The one-hundred-and-sixty-odd maps and diagrams are well chosen and clear and do much to assist the reader in the following text, and particularly in comprehending the seventeen regional chapters. There are also seventy-two plates.

The publishers claim that this book has been designed particularly for advanced students at schools and universities and yet, at the same time, it is likely to be acceptable to the non-specialist. Such diverse requirements are difficult to meet in one volume. The systematic section in particular would appear difficult for the non-specialist to understand on account of the use of technical terms unlikely to be known to the general reader, whereas the principal appeal at the university level seems likely to be to those students who rely on a limited number of textbooks rather than on extensive reading.

F. R. G.

The Mediterranean Lands. Advanced Level Geography Book 2. H. Robinson. 14 × 21·5 cm. viii + 468 pp. London: University Tutorial Press Ltd. 1960. 21s.

Dr. Robinson solves the problem of definition of the Mediterranean lands by including with varying emphasis all those lands that border that sea, together with Jordan which does not. A third of his book is given to a general description of the Mediterranean lands as a whole, to their history, structure, climate, essential characteristics, agriculture and economy. The remainder deals with each state in turn, but with more emphasis on the western peninsulas than on the smaller states of the Levant and North Africa. Within its limits of space the book is most comprehensive and virtually no important aspects of the geography are omitted.

The book is most competently and simply written without undue technical jargon. Designed for "A" Level students, it is well within their understanding, and ideas likely to be new to sixth-formers are well explained. The matter is well set out to facilitate learning. It is up to date, with good illustrations and adequate simple maps. Naturally it is not all equally successful. The difficult problems of structure are perhaps treated too lightly and the long section on climate is too disjointed. The chapters on the smaller states inevitably suffer from limitations of space and are very sketchy.

The book will certainly be most popular with students whose aim is "A" Level and it will be most successful along that line. But it is not the book to fire anyone's enthusiasm; nor is it the book to give to a young able student whom one hopes will do really well. It is all made too easy and too simple; there are too few ideas in it, too little to provoke thought or argument. The book should lay a sound foundation of knowledge, but it is very doubtful whether at the end of a course based on this book alone, the student would have any feeling for or any real understanding of what makes the Mediterranean a geographical unit today.

G. W. N.

Monsoon Asia. A Systematic Regional Geography, Vol. 5. E. H. G. Dobby. 14·5 × 22 cm. 381 pp. London: University of London Press Ltd. 1961. 25s.

This book is divided into four sections; the first and last deal with Monsoon Asia as a whole and the middle two with the different regions into which this part of Asia has been divided.

The book contains many photographs but their value is reduced because they are not well integrated into the text. There is, too, a rich variety of maps. Many are good and informative; a few display poor draughtsmanship or are so overloaded with detail that they are difficult to interpret fully. Some of the maps, constructed from large-scale topographical maps, are valuable but others lose some of their value by having incomplete keys. In later editions, it is hoped, Figure 41 will be redrawn and the little oddity, Figure 35, omitted.

In writing about man's activities Professor Dobby rightly lays the emphasis on farming, but many of his descriptions of the agricultural scene are dull and lifeless and give little evidence of the author's own field work. Urban geography is not forgotten and there are many good town studies. There is, however, at least one serious omission. The index gives eleven references to Calcutta but in none of them is there a full geographical description of this great and vital Asian city.

This is, undoubtedly, a useful and important book for it amasses a great deal of information about one of the most important regions of the world. Sixth-formers and training college students will benefit from studying it though many will find reading it a somewhat dull task. For livelier accounts of this great region they will have to turn to other works.

D. J. C.

Africa Central and South. Folded paper map. Scale 1 : 4,000,000. 98 × 142 cm. London: Michelin Tyre Co. Ltd. and Dickens Press Ltd. 1961. 6s.

This new and cheap folded map, covering the whole of Africa to the east and south of Mount Cameroun at the useful scale of 63 miles to the inch, supplies a mass of information that no atlas, however detailed, provides for so large an area. Railways, so dominant on most atlas maps, are shown only by thin black lines, but roads are, understandably, emphasized, with full details about surface and other conditions, and seasonal use: the well-known "strip roads" of Southern Rhodesia are specially distinguished, as are certain difficult routes and roads suitable for land-rover type vehicles. National Parks, Game Reserves and dense forest areas are clearly indicated by distinctive colouring, and small symbols show the principal mines and their products. A mass of data is provided for the use of travellers: the location of hotels, rest-houses (furnished or otherwise), safari bungalows (with or without restaurants), petrol stations, ferries (with details of motive power and of load capacity), and the like. The clear blue used for hydrographic features also shows whether or not car-carrying services are operating either throughout or for part of the year.

All this unusual and not readily available information underlines the special problems of travel still to be faced in Central and Southern Africa while at the same time indicating the remarkable way in which modern means of communication have opened up the continent in recent years. This map could be invaluable to the teacher who wanted to teach the geography of Africa in realistic terms and to stress that African towns are more than dots on maps and that not all Africans are hunting pygmies or nomadic Masai. Perhaps the most useful feature for the enterprising teacher and the enquiring pupil is the inset giving climatic conditions for seventy-four stations (with London and Paris added for comparison): for each place the average monthly rainfall is shown by a range of colours, together with the maximum and minimum average temperature for each month. The map has the further advantage for use in schools that it is likely to name a fair proportion of the places that occur in the news from Africa that receives so much prominence in these days.

E. M. S.

Australia, New Zealand and the Southwest Pacific. A Systematic Regional Geography, Vol. 4. K. W. Robinson. 14·5 × 22 cm. xii + 340 pp. London: University of London Press Ltd. 1960. 25s.

The Australian Environment. Commonwealth Scientific and Industrial Research Organization. 18 × 25 cm. 151 pp. Melbourne: C.S.I.R.O. in association with Melbourne University Press. London: Cambridge University Press. 1960. 30s.

Geographers who have felt the need for an up-to-date regional account of Australia will look hopefully at Mr. Robinson's handsomely produced book. They should know better than to be too hopeful, for Australia is notoriously difficult to divide into regions. Mr. Robinson has done his best, but he would probably admit that some of his regions mean very little to the people who inhabit them. His region-by-region description of Australia occupies 126 pages, and is followed by 28 on the regions of New Zealand and 19 on the islands of the southwest Pacific. The book opens with 88 pages of systematic treatment of structure, climate, vegetation, soils, animal life, native peoples and land use, and concludes with 50 pages on the relationship between geography and government in the several territories covered by the title. While this latter section is of considerable interest, it is the regional core of the book that justifies its claim to a place in a geography class library. The division of Australia into ten major regions and over forty sub-regions is based mainly on land use—so much so that the large tenth region, "Desert and Wastelands", is not described at all. In several chapters, effective use is made of

studies of representative farms. Mr. Robinson is at his best on farming, and his treatment of mining, manufacturing and urban centres is less satisfactory. Treatment of New Zealand is disappointing, and two of the maps of his homeland are very crudely drawn, while the map of power stations on the Waikato river is out of date. On p. 6, "Angaraland" should read "Gondwanaland".

In teaching the geography of Australia and New Zealand at university level, this reviewer has long preferred the topical to the regional approach, and for this reason the appearance of a revised edition of *The Australian Environment* is a welcome if overdue event. Originally compiled as a handbook for an agricultural conference, this book became deservedly popular and went out of print. The new edition has been considerably rewritten, and given a larger format. A better quality paper does more justice to the photographs, many of which are new. The excellent coloured maps of relief, soils, vegetation and pastures re-appear on a larger scale (1 : 17,000,000) as fold-ins. The nine chapters deal with physical geography, climate, soils, the development of agriculture, water and irrigation, vegetation, pastures, field crops and livestock. The editor of the new edition is Professor G. W. Leeper. *The Australian Environment* is essential reading for students of Australian geography.

J. S. D.

A Regional Geography of South Australia. D. D. Harris and D. A. M. Lea. 19 × 25 cm. 168 pp. Melbourne: Whitcombe and Tombs Pty Ltd. 1961. 18s. 6d.

There are not many textbooks available in England which offer detail of Australia beyond the needs of lower forms in secondary schools and regional studies of its individual states are even rarer. However *Queensland—City, Coast and Country* by R. H. Greenwood was published in 1959 to coincide with the centenary celebrations of that state, and this is now followed by a study of South Australia, written by two masters at King's College, Adelaide.

Designed for use in the lower forms of secondary schools, this book has a practical approach to regional studies which leads on from observation to recording and interpretation. For the first of these stages, numerous photographs, maps and diagrams supplement the written word, whilst exercises and questioning captions encourage the reader in the succeeding phases.

Several extracts from sheets of the Australian topographical series covering South Australia, each occupying a full page without margins, add to the interest of the contents. The value of these maps to readers outside Australia, however, is diminished by the absence of any key to the symbols, and only in questions on the two quarter-inch maps is the scale stated or implied, although numerous exercises demand a working knowledge of these. Nevertheless it is an attractively produced text, containing much regional detail unfamiliar to English students, and as such deserves to be available on the shelves of the geography library for comparison with English texts.

L. J. J.

A Dictionary of Geology. J. Challinor. 14·5 × 22 cm. xv + 235 pp. Cardiff: University of Wales Press Ltd. 1961. 30s.

Dr. Challinor's book should be a welcome addition to any standard collection of reference works in college or sixth-form libraries. It makes no claim to be comprehensive but by examining "the meaning, usage of names, terms and concepts of the science it attempts to be a critical and historical ABC of the subject". The great merit of the volume is that the lexicographer has included wherever possible quotations from the source material thus defining the meaning of the terms in the original words of the authors. Each reference is fully documented and a useful

sub-section of the book is the classified index although this has not been arranged alphabetically.

Geographers will find that almost all geological terms they are likely to need are included. Nearly every rock type is defined but less attention is given to other aspects. Geomorphology on the whole is adequately covered although there is only a small number of items used in describing desert or peri-glacial landforms or processes. A rather surprising omission is the term (k)nickpoint. A typographical error was noted on p. 26, "bragchia" should read "branchia".

The author is to be congratulated on presenting this work of scholarship and his publishers for producing it at such a reasonable cost.

R. H. J.

The World of Geology. L. D. and F. J. Leet. 14·5 × 21·5 cm. vi + 262 pp. London: McGraw-Hill Book Inc. 1961. 21s. 6d.

This paper-back volume presents a collection of essays previously published in a wide range of books and periodicals. The total assemblage forms a useful introduction to the wide compass of interests now pursued by geologists. The book is well illustrated.

Some of the essays are in narrative form—a description of the Killauea eruption and the voyage of the *Trieste* to the floor of the Challenger Deep. Others are abstracted from well-known general accounts, e.g. Shand's *Earth Lore* or Carson's *The Seas Around Us* and their inclusion is perhaps unnecessary. The most informative are the special articles based on research monographs; especially useful are those by H. Williams on Volcanoes, Leet's on Earthquakes and the contribution on the geology of the Appalachians. Too general perhaps for a college or school reference book, this volume will stimulate the general reader to pursue his geological enquiries further.

R. H. J.

Fossils. The New Naturalist Series. H. H. Swinnerton. 15·5 × 22·5 cm. xiv + 274 pp. London: Collins Ltd. 1960. 30s.

Fossil Collecting: An illustrated guide. R. Casanova. 16 × 21·5 cm. 142 pp. London: Faber and Faber Ltd. 1960. 18s.

"Fossils are not merely stones, not merely curiosities . . . , they have a meaning and tell a story. The purpose of this book", writes Professor Swinnerton, "is to relate briefly how that meaning was uncovered and that story unfolded." In this handsome contribution to the New Naturalist series he succeeds admirably in his intention. A brief introductory section carries the reader from the first speculations about "figured stones" to the laying of the foundations of stratigraphy and palaeontology, and makes him vividly and fascinatedly aware of the ideas and personalities of the great pioneers. This is maintained in the main part of the book which deals in order with the geological eras and combines with equal felicity a clear narration of the story of the fossils with an account of how that story was unfolded.

Professor Swinnerton writes primarily for British readers; Mr. Casanova's book suffers by being an English edition of a book originally designed apparently for North American readers. In about half the length of Professor Swinnerton's book he surveys not only similar ground but includes chapters on biological classification, on collecting and preparing fossils and on fossil localities in Great Britain. This necessitates extreme compression and the result is often pedestrian. Moreover the book gives no clear impression of a definite purpose or for whom it is intended. Very elementary geological information is included with descriptions of quite elaborate methods of preparing fossils.

Both books are attractive in appearance with pleasant type-faces and excellent illustrations.

G. de B.

An Introduction to Human Geography. J. H. G. Lebon. 2nd edition, revised. 12·5 × 19 cm. x + 199 pp. London: Hutchinson University Library. 1959. 10s. 6d.

The issue of a revised edition of this book, which was first published in 1952, is welcome. Its broad plan remains unchanged, but minor errors have been corrected and the structure of the chapters has been made more apparent by the insertion of sub-headings.

In the author's view human geography seeks to elucidate the general problem of man's relationship with his environment and this theme is considered in a series of essays which are mainly oecumenical in character. Sometimes, however, general principles are discussed by means of relatively detailed regional studies, as in the chapter on "The Problem of Equilibrium" of which four-fifths deal with South Africa. Professor Lebon does not offer any clear definition of the scope of human geography or say, for example, whether he would include political geography among its subdivisions. The first chapter, dealing with Tradition and the Modern Conception of Geography, is succinct and lucid but pays special attention to what is termed the French School and much less to developments in other countries.

The book is well written and stimulating, pointing the way to many lines of enquiry, and providing the student at school or university with a most useful *Introduction.*

A. McK. F.

CLIMATE AND WEATHER STUDY

Meteorology and Climatology for Sixth Forms and beyond. E. S. Gates. 19 × 25·5 cm. 203 pp. London: G. G. Harrap & Co. Ltd. 1961. 13s. 6d.

The Weather and Climate of the British Isles. R. Kay Gresswell. 14·5 × 22 cm. 142 pp. London: Hulton Educational Publications. 1961. 8s. 6d.

In format, style and general excellence Mr. Gates's book has much in common with its much-loved forerunner from the same stable, H. Alnwick's *Geography of Commodities.* Sixth-form teachers will welcome this addition to the small number of books explicitly written for their pupils. The author's long experience in this work is evident from the terse yet lively way in which he systematically presents all the information, theories and statistics necessary. The treatment is graded from first principles, e.g. on lapse rates and laws of gases, to reach frontal theory only in Chapter 10. Many diagrams, refreshingly drawn without stencils, tables and photographs of uniform clarity cover inversions, geostrophic winds, jet streams, vapour trails, fog, mirages, forecasting and every other topic. Appendices give terms, codes and characteristics used in forecasting.

Moving on to climatology, a discussion of planetary principles leads to a simple and realistic division of the world into thirteen climatic types, based on Köppen's system. These are illustrated with graphs and their main features are briefly accounted for. A final chapter introduces readers to the response of natural vegetation to climatic controls. World distribution maps are given for every relevant topic.

All schools working to "A" level should have this book. Past questions, short chapters with cross-references and calculated repetition facilitate the study of any one theme.

Dr. Gresswell succeeds his popular little books on geomorphology with a similar one on meteorology, weather and the British climate. The style is arresting, with a determined flavouring of "gimmicks". Nevertheless, the book is packed with sound information and clear, detailed reasoning, which extends into physics where necessary.

Many diagrams, tables and photographs are well integrated into the text. All the work in meteorology for "O" and "A" level syllabuses is included and there are particularly good sections on "wet air", "falling water", "moving air", air masses, depressions and lightning. The final section on the British climate is more a thought-provoking exploration of responses in human geography to our climatic contingencies, well laced with out-of-the ordinary statistics and absorbingly unorthodox. This is a library book which will appeal to all secondary pupils.

P. A-J.

General Climatology. H. J. Critchfield. 16 × 23·5 cm. xiii + 465 pp. London: Prentice-Hall International, Inc. 1960. 50s.

Few authors of meteorological and climatological textbooks have attempted so broad a coverage as Professor Critchfield. Of the three sections, physical, regional and applied, the last is the most distinctive and, perhaps to geographers, the most interesting. In 180 pages the relationships between climate and the world pattern of soils, vegetation, water resources, communications, industry and man's health are considered in a succinct though occasionally excessively superficial manner. This section concludes with a short chapter on climatic change.

The first section on physical climatology is a description and explanation of the world distribution of climatic elements and the instruments by which they are measured. This is a very compressed analysis of physical processes, not without occasional errors such as the confusion between condensation and freezing nuclei, and sometimes hampered by an overzealous and dubious ideal to produce a book with a non-technical approach. Regional climates are described in terms of air masses but little attention is paid to the responsible seasonal dynamic influences, leaving the reader with a rather lifeless non-genetic account.

By present-day United States standards, the book is moderately priced but this has been achieved with some sacrifice in the legibility of several maps and photographs, the majority of which (including weather maps) are biased towards a North American market. To British sixth-form students the book's value lies mainly in its comprehensiveness and its summary of applied climatology.

T. J. C.

Clouds. Part A: Haze, Convection Clouds, Ice Clouds. 24 frames. Part B: Layer Clouds, Wave Clouds, Billow Clouds. 25 frames. F. H. Ludlam and R. S. Scorer. Each part 27s. 6d. (single frame); 37s. 6d. (double frame).

Unstable Weather. Growth of a Cumulonimbus. 15 frames. **Stable Weather.** The Causes and Effects of Inversions. 15 frames. R. S. Scorer. Each 27s. 6d. (double frames only). London: Diana Wyllie Ltd. 1961.

The names of F. H. Ludlam and R. S. Scorer will have been known for several years to most geography teachers who have some interest in meteorological research and more widely, perhaps, for their successful pictorial guide *Cloud Study* which was published under the auspices of the Royal Meteorological Society in 1957, but it may not be generally known that selections from their magnificent library of cloud photographs in colour are available in film-strip form. However, the two strips under the title *Clouds* are not intended merely to provide a cloud atlas, i.e. a series of photographs for purposes of recognition and identification. As the authors themselves point out: "the sky is infinitely variable and will never be a precise replica of the illustrations in any catalogue. It is well known that it is often difficult to name clouds correctly for this reason. . . ." The purpose has been rather to use the photographs to illustrate the physical processes which determine the genesis and the development of the different cloud types in accordance with the most recent theories.

Accordingly, the detailed, and occasionally slightly complex, notes which accompany the strips contain a great deal of authoritative information, much of which is not available in textbooks. They therefore repay the very careful study which is essential before the pictures are used in class.

Briefly, a broad distinction is made between the mode of formation of "single-layer clouds" (fog and stratus) produced by overnight chilling or by advection; "multi-layer clouds" (cirrostratus, altostratus, nimbostratus) produced mainly on the warm fronts of an advancing depression; "convection clouds" (cumulus and cumulonimbus) produced by local heating, either from the ground or at higher levels in the atmosphere; "wave clouds" produced by variations in relief and, finally, a group which might be termed clouds of secondary modification, i.e. those whose structure is altered by the growth of ice crystals or by the presence of inversions or by particular winds. Each type is illustrated by carefully selected photographs which are analysed in detail in the notes. Cumuliform clouds are obviously most photogenic and present little difficulty but even the almost featureless sheet clouds are successfully and attractively depicted, partly by air photographs of "cloud seas", partly by introducing effective foregrounds to give scale and balance, as in the illustrations of altostratus and hill fog which might have been thought to be almost impossible subjects.

Inevitably, we are introduced to a somewhat specialized terminology for, in addition to the established cloud names and their adjectival qualifications (congestus, translucidus, undulatus, etc.), we meet such varieties as pileus caps, rotor clouds and helm bars. However, none of the concepts involved is beyond the intelligence of the average sixth-form geographer and, in any case, as with all film-strip work, it is up to the teacher to make a judicious selection of the material in accordance with the standard and requirements of the group. As usual, the problem of how to make the best use of these strips in the sixth form will turn not so much on the complexity of the subject-matter as on the amount of time that can be spared from an already overcrowded syllabus. A solution would be to acquire the double-frame version and convert the most useful pictures into slides.

In his new pair of film-strips, on stable and unstable weather, Dr. Scorer takes the same theme a stage further, concentrating attention on two particular and contrasting types of weather conditions. The first deals with instability in the atmosphere as revealed by the formation of cumulonimbus clouds in a variety of aspects. Detailed observation of these majestic cloud masses provides the evidence of their mechanism, associated winds and mode of precipitation and the photographs are further elucidated by means of excellent diagrams in the strip. The strip includes the famous sequence of eight photographs taken during the growth of an intense isolated thunderstorm in Iowa. Reference is made to the refraction phenomena which may be observed in cumulonimbus anvils and there are also reproductions of radar pictures of storms.

By contrast, the second strip deals with stability in the atmosphere and hence analyses the causes and effects of inversions at various levels. The photographs are again very well chosen, particularly effective being those which show smoke rising from the chimneys of a power station and then spreading out at a 500-foot inversion and one of a "frost hollow" on a winter morning. There is also a fine aerial view of a valley filled with fog so dense that it resembles an inlet of the sea.

To the layman, the technical quality of the photography and reproduction in all these strips is excellent. It is true that the contrast is rather high in some of the frames and this leads to somewhat violent coloration, particularly striking to those who have not strayed far from the pale and limpid skies of our own latitudes. On the other hand, many of the photographs are extremely beautiful and since their subject is largely concerned with the effects of light they obviously gain enormously from projection as compared with the flat and lifeless printed photograph.

In the copies of *Stable Weather* and *Unstable Weather* which were submitted for review the frames were unnumbered. This omission, if normal to production, makes it difficult to use the numbered cross-references which occur several times in the notes. Similarly, the pictures of the Iowa storm should have been lettered to correspond with the references in the text. However, this does not seriously detract from the general merit of these strips which are calculated to stimulate the interest of the most indifferent pupils. For, quite apart from their academic interest, it would surely be impossible to view these pictures without gaining an added awareness and appreciation of the sky in all its moods. Their usefulness is certainly not restricted to the sixth form and if they succeed in encouraging children to lift their eyes beyond the hoardings and neon lights and to make their own observations of clouds and weather they are an excellent investment in any school.

R. H. C. C-G.

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